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DATE OF REPORT: 21 May 1957

SUBJECT: Iron, Steel and Nonferrous Metal Industry

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SUMMARY

1. Transmitted herewith is a publication entitled "Yugoslav Iron, Steel and Nonferrous Metal Industry," published by the Federal Chamber of Foreign Trade in Belgrade.

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2. Photos showing portions of the following plants are included: Iron and Steel Works of ZENICA, JESENICE, and SISAK; Iron and Steel Works at STORE, RAVNE and VARES; Copper Rolling Mill at SEVOJNO; Cable Works at SVETOZAREVO; Lead Mines and Smelting Works at MEZICE; Aluminum Plant at KIDRICEVO; and the JUGOHROM Chrome Products Factory.

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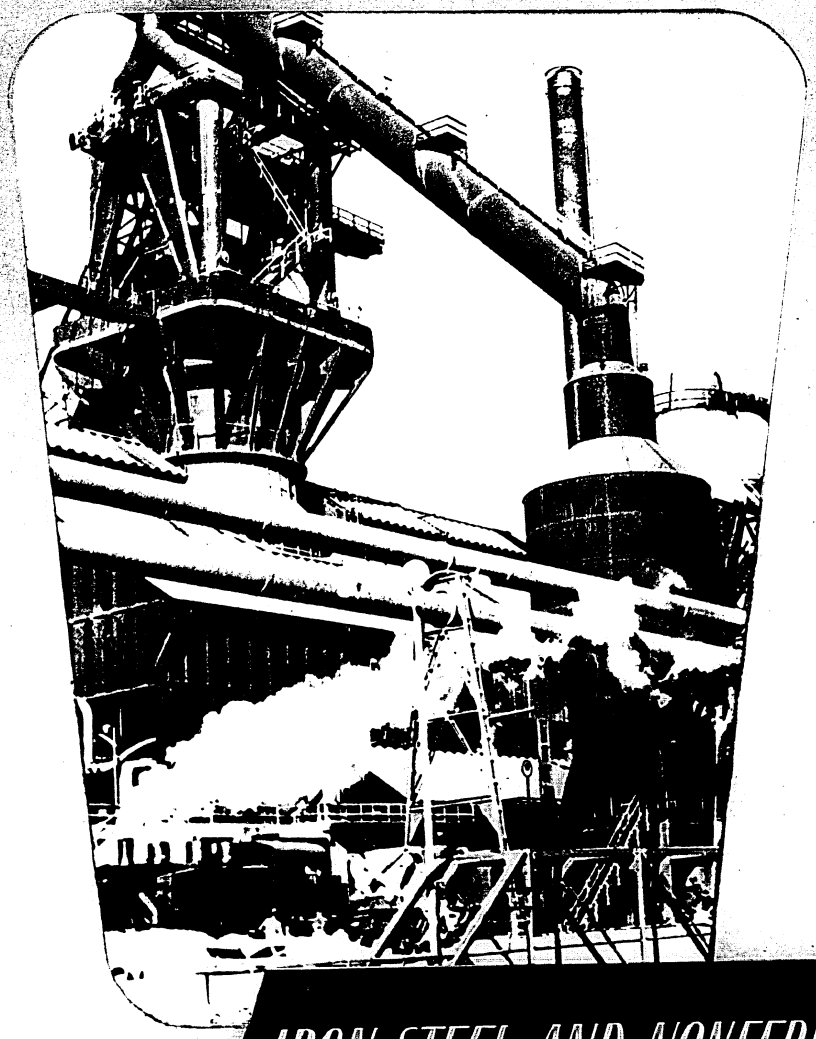

IRON STEEL AND NONFERROUS METAL INDUSTRY

Published by FEDERAL CHAMBER OF FOREIGN TRADE BEOGRAD

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Published by Federal Chamber of Foreign Trade, Beograd

IRON STEEL AND NONFERROUS METAL INDUSTRY

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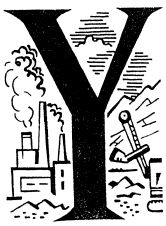


Yugoslavia possesses all the prerequisites for the development of a successfull ferrous metallurgy. The chief elements necessary for a rational and economically practicable iron and steel production and which Yugoslavia possesses are following:

— Iron ore reserves amount to over 250 million tons which constitutes enough raw material for many decades. Iron ore from Ljubija is well known for its high reducibility and purity beyond the frontiers of Yugoslavia, and has been, for this reason, in great demand as an export item. The siderites of Vareš, although poorer in ore than the limonites and siderites of Ljubija, are nevertheless, after roasting and sintering, excellent raw material for blast furnaces. These ores also contain over 2% of manganese and thus a good deal of manganese ore and ferromanganese is saved in production of steel. All the plants producing pig iron have the necessary equipment for preparing the ore and coke, while specially erected ore agglomerating and sintering plants make possible the smelting and processing not only of enriched ores, but also of various other iron residue, such, as dust from blast furnaces, bauxite residues from the production of aluminium, and residue from the production of sulphuric acid out of pyrites an pyrrhotine.

Known reserves of brown coal, with sulphur content within allowed limits, supply the fuel necessary for gas generators of industrial furnaces in steel plants and rolling mills, are adequate also for the future needs of a further developed production of ferrous metallurgy. The newly built coke plant and furnaces at the steel mill of Zenica make possible the full recovery of exhaust gases from the blast furnaces, as well as the recovery of coking gases resulting both in considerable saving of fuel and improved quality of iron as well as a simultaneous rise in the productivity of labour. For the same reason residues of oil refineries are used as fuel, while the use of natural gas for open-hearth furnaces is being considered.

— Domestic factories of refractory materials supply the iron and steel industry with excellent fire clay bricks, silica bricks, and magnesite and chrome-magnesite bricks, while

FERROUS METALLURGY

Iron and Steel Works, Jesenice

ferro-alloy factories produce ferro-silicium, ferro-manganese, ferro-chrome and ferro-tungsten in such quantities, from domestic raw materials (with the exception of high-grade manganese ore, which is imported), that these products are even exported.

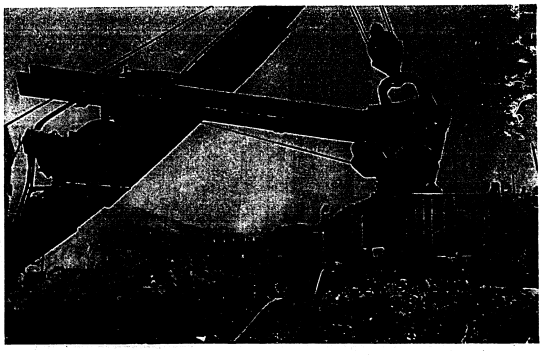
— Owing to very large water power potential it has been possible to produce cheap electric energy making it possible to proceed toward the production of pig iron and crude steel in electric arc furnaces and high-frequency electric furnaces, and to use, in the greatest possible measure, other kinds of industrial electric furnaces. The production of electro-steel already amounts to 5% of the total production of crude steel, and it will reach over 10% as soon as the new plants now in construction are finished. The same applies to the production of electrically smelted pig iron which will be over 10% of the total production.

By using mechanization and automation to the highest degree, wherever it is economical; by raising the productive capacity in all stages of manufacture and processing; and by simplifying transport by means of special railway cars and rubber conveyor belts; with all these measures a considerable improvement in the productivity of labour has been effected in the coal and iron ore mines and in the steel mills so that in some cases the productivity will be several times that of pre-war years. The rise in productivity can best be seen from the following table:

Production and plant productivity

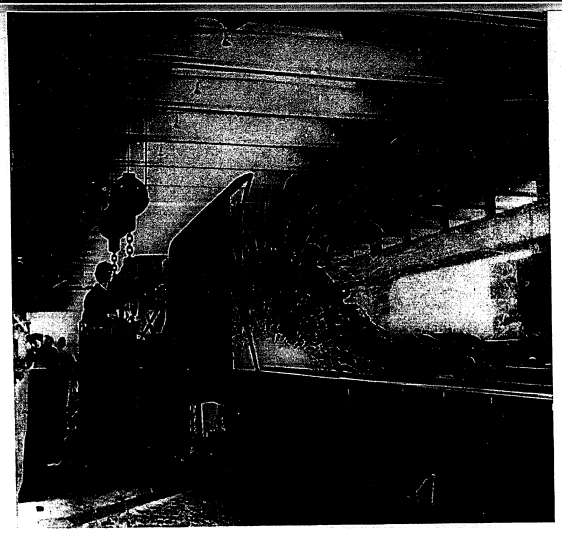
Type of furnace	Production				Productive capacity after new plants are finished	
	1939		1955			
	Number of furnaces	Tons per furnace	Number of furnaces	Tons per furnace	Number of furnaces	Tons per furnaces
Blast furnaces	5	20,000	9	56,000	8	110,000
Open hearth furnaces	13	17,800	21	36,000	26	46,700
Electric furnaces	1	2,800	10	4,600	16	8,900

With the rise in the productivity of plants, the productivity of labour rises too. Thus, for instance, in 1955, and taking the index number of 100 for 1954, the index for the production of ferrous metallurgy in the whole country was 131, while the index number of employees was only 112. This means that the productivity of labour had gone up 17%. The rise in productivity was biggest in Bosnia, where there was a considerable rise in the production of iron ore, pig iron, steel, and of finished steel products, so that the production index of



ferrous metallurgy in that part of the country, for the same year, was as high as 147, while the index number of employees was only 118. This means that the productivity of labour had gone up 24%. Before the war, the biggest blast furnace in the country could hold a charge of 135 m³, while today there are furnaces of 860 m³ working. And similarly open hearth furnaces, before the war, produced from 10 to 60 tons per charge at the most. Today the principal Martin furnaces have a capacity ranging from 60 to 180 tons per charge each, while the smaller furnaces are used only in smaller enterprises, and for special kinds of steel. Near the old crude rolling mill, after the war, a new up-to-date blooming mill has been built at Zenica which has a productive capacity of 450,000 tons of ingots annually, compared to the biggest old type of plant which had a productive capacity of only 180,000 tons of ingots annually.

The building up of ferrous metallurgy required many sacrifices and great efforts, but, on the other hand, the steel and iron production will affect favourably the foreign trade clearance balance, since the needs for foreign currency to pay for imported raw materials (still needed from abroad) will be reduced to about 25% of the funds which were formerly needed to pay for imported finished rolled, drawn, and hammered steel, to satisfy the needs of industry built so far. This is all the more to be expected since all the other necessary raw materials and cheap electric power are available. The necessary number of highly skilled, skilled, and partially trained personnel have become experienced at their jobs, thanks to the fact that ferrous metallurgy enterprises have always had, through the centuries, a body of skilled old workers who had grown with the enterprises. Beside this, the enterprises have availed themselves of the experienced foreign experts, especially those who were sent by the UN Technical Assistance. Yugoslav experts have also been given opportunities to go abroad and specialize there.



From the Iron and Steel Works, Sisak

The products of ferrous metallurgy in Yugoslavia

In accordance with the nomenclature accepted by the statistics service of the Steel Commission of the U. N. Economic Commission for Europe in Geneva, the products of ferrous metallurgy in Yugoslavia include the following:

Iron ore with:
- a) over 42% Fe content
- b) under 42% Fe content.

Pig iron:
- a) white pig iron for steel making,
- b) gray pig iron from blast furnaces using coke as fuel
- c) gray pig iron from blast furnaces using charcoal as fuel
- d) gray pig iron from electric furnaces using coke as fuel
- e) gray pig iron from electric furnaces using charcoal as fuel

Crude steel:
- a) from open-hearth furnaces
- b) from electric arc furnaces
- c) from high frequency electric furnaces
- d) from Bessemer converters

Steel products hot rolled, forged or drawn, grouped as follows:

a) railway rails and accessories
b) heavy beams and structural shapes over 80 mm Ø
c) medium, light and fine beams, structural shapes, concrete-reinforcing rods and flattened rods, under 80 mm Ø
d) hot-rolled wire
e) round and square semi-finished, or special ingots for tube production
f) hot-rolled strips under 500 mm wide, including semi-finished product for the manufacture of welded tubing
g) thick and medium sheets, including strips over 500 mm wide, and universal steel over 150 mm wide, — all over 3 mm thick
h) thin and fine sheets, including strips over 500 mm wide, all under 3 mm thick
i) other products, including bands and car-wheel material
j) ingots and semi finished products which are exported or used by industries other than ferrous metallurgy.
k) forged thin beams and rods
l) steel castings.

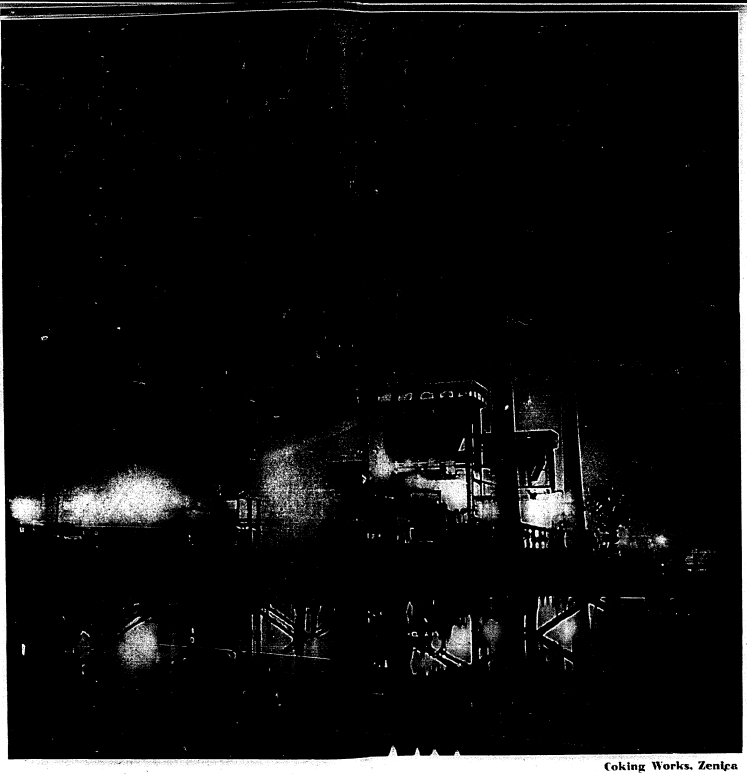
Three kinds of heavy rails are produced in Yugoslavia, with a maximum weight of 45 kilos per linear metre, and various industrial rails ranging from 7 to 12.5 kilos per linear metre. Together with the rails all the accessories are delivered.

Other items produced are: Channel and I beams from NP 4.5 to NP 40 corresponding angles from 20×20×3 mm to 200×200×17 mm; structural steel from 40×60×5 mm to 100×200×10 mm; special structural steel for windows; round rod steel from 5 to 80 mm Ø; semi-rounded from 10/5 to 30/15 mm; flattened steel from 10×5 mm to 130×40 mm and wider; square steel from 5 to 80 mm; hexagonal steel from 8 to 80 mm; concrete reinforcing steel from 5 to 40 mm. and thicker; rolled wire, square and round, from 5 to 12 mm, flat rolled wire from 4.2×4.8 to 6×7.5 mm and 9×4 mm; strips from 140×10 mm to 370×40 mm; steel hoops from 10×1.25 to 120×4 mm; octagonal steel from 12 to 30 mm in diameter; segment steel for casks from 25×8 mm to 30×10 mm in diameter; H steel for casks — 30×25×4 mm; steel for the manufacture of bottoms of milk cans — 46×8×2 mm; wedged section steel — 20×3×1. Sheets are further produced, in thickness over 5 mm thick and up to 2000 mm wide, medium sheets from 3 to 5 mm thick, thin sheets from 1 to 3 mm thick, and fine sheets from 0.30 to 1 mm thick, dynamo sheets from 0.5 to 1 mm thick, high grades of ship and steam-boiler sheets of various grades, ribbed sheets from 4 to 5 mm thick, oval and semi-oval plates, plates for cultivators and ploughs. Sheets are delivered as black, once or several times decapated sheets, or as galvanized sheets. Cold rolled strips of various width and thickness can be delivered, varying from 0.095 mm thickness and 6 mm width to 4 mm thick and 650 mm wide strips, and they can be dark or white-roasted, of various grades of hardness, their strength ranging from 32—40 kg/mm² to 55—65 kg/mm². They can be made with different edges, normally or highly polished, light, galvanized or leaded, and paper sheathed.

The wire produced includes: black, light, galvanized, or copper-coated wire, from number 1.4 to number 64, and further. It can be delivered as dark-blue or dark-roasted wire, in rolls. Special kinds of wire produced include: rectangular, semi-rounded, hexagonal and flattened wire, and special book-binding wire and patent wire, its strength ranging from 100 kg/mm² to as much as 260 kg/mm².

Welded tubing is produced in dimensions ranging from 1/8" to 3" as gas-pipes, water-pipes and steam-pipes, together with fittings and elbows, in black, galvanized, or drawn. Of the special welded tubing, round and square tubing for furniture (the round from 12×2 mm to 33×2.5 mm) should be mentioned. Armoured tubing is further produced, from 9 to 42 mm, and square tubing for constructions from 30×3.25 to 65×4 mm.

Seamless tubing of all dimensions is produced, from 1/8" to 16", adjusted, while in a short time the production of galvanized, bitumen-coated and drawn tubing will also be produced. API tubes are specially manufactured, with special fittings for the oil industry, which can be used, in case of need, as poles for long distance power



Coking Works, Zenica

Footnote: According to the Yugoslav nomenclature, finished castings (with the exception of forged thin beams and rods) and steel castings are in the group of products of metal manufacturing industries.

transmission lines. For special purposes, round, square or flattened, drawn or bared steel is produced, from 4.5 to 60 mm and more, annealed normalized, thermally processed, or alkali-treated, in rods.

Tool steel of all kinds and of many grades, low or highly alloyed, as well as carbon non-alloyed steels are manufactured. Special kinds of steel such as highly alloyed steels, stainless steel, and steels to withstand high temperatures and corrosion, are also manufactured.

In the forging plants, forged narrow beams and rods are made, and heavy structural forgings, based on submitted designs, of up to 1,200 kg in weight are produced while forge-presses manufacture various structural and other kinds of forgings, up to 30 tons in weight.

Almost all the most important types of carbon and alloyed steel (over 120 different kinds) are produced, so that iron and steel plants can easily satisfy the requirements of all consumers.

Beside finished steel products crude steel is sold in ingots weighing up to 5 tons, as well as various semi-finished products such as slabs and coatings.

White pig iron for steel making and gray pig iron for foundries is produced. Owing to a high percentage of manganese present in Yugoslav iron ore, white pig iron with 3% of manganese content can be manufactured to meet special needs.

Some iron and steel plants use their raw and semi-finished products to manufacture finished goods, which strictly speaking does not fall under ferrous metallurgy. Thus, the iron and steel plant of Jesenice manufactures nails, bare, coated, and cored welding rods, and springs for furniture. The iron and steel plant of Ravne processes most of its crude steel products to make complicated dressed steel castings, and forges various complex forgings to supply the needs of the Yugoslav industry. This iron and steel plant manufactures all kinds of industrial cutters, knives, circular saws, forged rolls for mills, etc.

The iron and steel plant of Store processes gray cast iron from its own electric furnace in its foundry where it manufactures cast iron pipes, rolls for rolling-mills and other industries, moulds of all kinds and other types of castings. Similarly, the iron and steel plant of Smederevo processes part of its products in its own forging and pressing shop where it manufactures various agricultural equipment and other forgings and pressings.

A survey of the development of ferrous metallurgy up to World War II

On the territory which constitutes Yugoslavia of today mining and smelting activities were already well developed under the Celts, the Illyrians and the Romans. Many old abandoned mines which have been discovered, and many finds collected and kept in museums all over the country, especially in the museums of Sarajevo, Ljubljana and Maribor, as well as various primitive tools, arms, consumer goods and decorative objects, — all speak plainly of the craftsmanship of those early settlers. The virtues of the »Celt-Noric« iron products were sung by Roman poets, while iron forgings were in use even in the times when the inhabitants of the Ljubljana marshes still built their huts on poles above the marshy ground.

Mining and smelting continued developing after the ancestors of the Yugoslavs of today moved into these areas. In Slovenia, as old documents testify, iron ore was mined as early as 1004 at »Stare Fuzine«, while the first known law on mining at Jesenice was passed in 1381. In 1953, during the construction of the new highway from Kropa to Jamnik, a well preserved »Slav blast furnace« was uncovered, which in all probability was the dominant primitive type of low blast furnace used in the Sava River basin from the end of the 14th century and up to as far as the beginning of the 19th century. In the upper part of the valleys of the Sava and Krka rivers, and in the valleys of the Drava and Meza rivers, in Koruska, there used to be many »plavzi« (smelters) and »fuzine« (forges), out of which, over the centuries, grew big iron plants competing successfully with similar plants abroad as long as they had sufficient quantities of iron ore and wood in the forests from which they made charcoal for the blast furnaces. Iron plants were usually erected beside rivers or large brooks in order to use water power to blow the bellows which supplied the smelting furnaces with sufficient air and to drive forge hammers.

Toward the end of the 18th and during the 19th century, after the forest-wood reserves were exhausted together with the ore deposits in small mines, and after the discovery that coke could be made from bituminous coal, many iron plants got into difficulties. Their primitive methods could no longer compete with the iron and steel enterprises in the world which were being transformed into real industrial enterprises. In 1774 an iron and steel enterprise was founded at Ravne, in Koruška, (out of which grew the iron and steel industry of Ravne of today) which succeeded in maintaining its independence even in those critical times. In 1869 the Kranjska Industriska Družba (Industrial Company of Kranj) was founded, which by 1874 acquired almost all the iron ore mines and all the smaller iron plants in Gorenjsko, such as those at Jesenice, Javornik, Bohinjska Bistrica, Mojstrana, Podnart, and so on. Out of the Industrial Company of Kranj grew the present day iron and steel plant of Jesenice, which celebrated its 80th anniversary last year. The present iron and steel plant of Store, near Celje, has been working since 1851.

In the other parts of Yugoslavia, in Serbia and Macedonia, mining activities of considerable extent began during the reign of King Uros, and the mines and

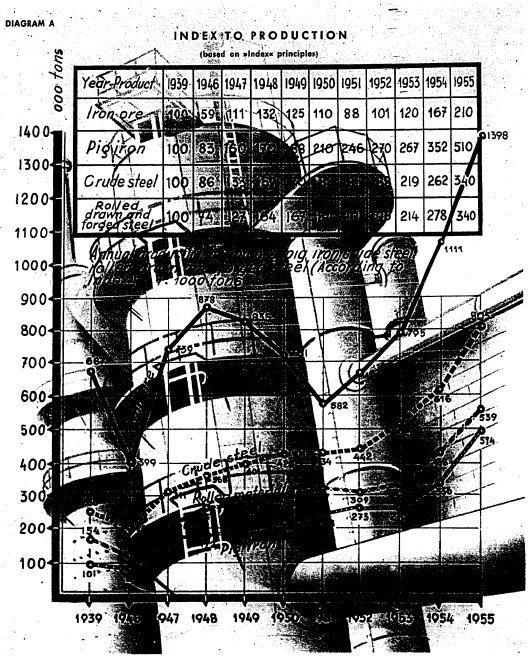
Detail from the Coking Works, Zenica

DIAGRAM A

INDEX TO PRODUCTION

(based on »Index« principles)

Year Product	1939	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Iron ore	100	59	111	132	125	110	88	101	120	167	210
Pig iron	100	83	[illegible]	[illegible]	[illegible]	210	246	270	267	352	510
Crude steel	100	86	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	219	262	340
Rolled, drawn and forged steel	100	74	122	164	167	[illegible]	[illegible]	[illegible]	214	278	340



smelters of those days were one of the chief sources of the country's wealth. In Bosnia, mining and smelting developed already during the reign of Kulin Ban. But after the Turks invaded and occupied these areas this branch of economic activity declined although some mines continued working. The Austro-Hungarian monarchy, which took Bosnia from the Turks in 1878, found there still as many as 54 iron ore mines which excavated ore from 64 deposits. The chief mines in Bosnia were grouped round Ljubija — The Old Mine, Vareš and Kreseva-Dezevica. The new occupying power began systematic exploration of the natural riches of Bosnia and Herzegovina, and then their exploitation to supply the needs of its own developed industry. Thus in 1891 the first blast furnace at Vareš started working, and in 1893 the production of steel and rolled material began in the iron and steel plant of Zenica. In 1916 the Austro-Hungarian monarchy began exploiting the well-known iron ore mine of Ljubija. All the three mines have been working uninterruptedly since they were founded, and out of them have grown the present Ljubija mine, the iron mine and steel plant at Vareš, and the steel plant at Zenica.

Mining and smelting activities in Croatia developed on a smaller scale. The smelting furnaces of Ruda, which processed iron ore from Somborske Gore, were well known, and from 1855 onwards the mining centre east of Karlovac, (where in ancient times the iron ore from the region of Petrove Gore was processed) came to

Blast furnaces at the Iron and Steel Works, Zenica

life again. Small blast furnaces at Topusko (Beslinac and Vranovina) produced excellent pig iron until World War II.

The productive capacity of the entire iron and steel industry, just before World War II began, was as follows:

Iron ore (the Vareš mines, the Ljubija mines and all the others) about	900,000 tons annually.
Pig iron (blast furnaces: two at Vareš, two at Jesenice, a small one in Sisak, and two small ones at Topusko and at Beslinac)	170,000 tons annually.
Crude open-hearth steel (5 furnaces at Zenica, 5 furnaces at Jesenice, and one each at Štore, Smederevo and Ravne)	306,000 tons annually
Electro-steel (one electric furnace at Zenica and one at Jesenice)	10,000 tons annually.
Finished products (rolling-mills and processing plants) approximately	290,000 tons annually.

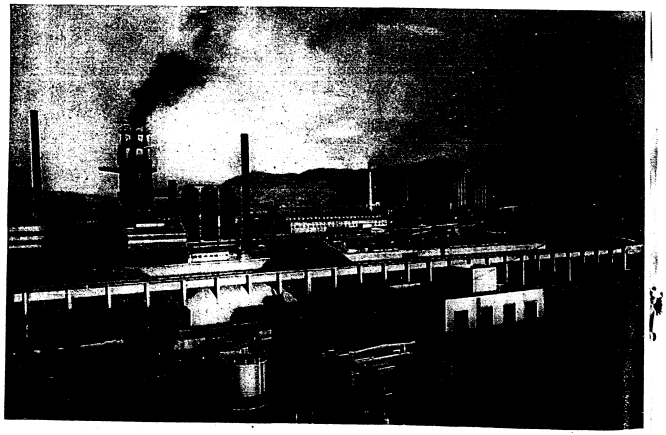
The production of ferrous metallurgy before World War II was a modest affair while the existing plants were put to poor use. Iron ore production was far above domestic consumption, so that about two thirds of the ore produced annually was exported, to be processed abroad.

Thus, the production of ferrous metallurgy in 1939 the last prewar year in which normal conditions prevailed was as follows:

Iron ore	666,913 tons
Pig iron	101,000 tons
Crude open-hearth steel	232,000 tons
Crude electro-steel	2,800 tons
Finished steel products, rolled, drawn, and forged	154,000 tons

The production of finished products was limited, in the main, to those assortments which were consumed mostly in the country, viz.: rails and various kinds of heavy, medium and light sections, beams and structural shapes and, to a much smaller degree, various kinds of sheets, cold-rolled strips, drawn wire and welded tubes, — all made almost exclusively from non-alloyed steel, because the production of electro-steel was inconsiderable.

View of the Zenica Iron and Steel Works



From the Zenica Iron and Steel Works

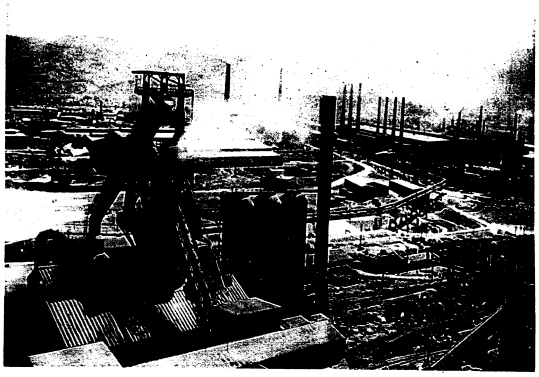
During World War II and the subsequent occupation of the country by the enemy, the production in nearly all the enterprises of ferrous metallurgy gradually declined, either because of war activities undertaken to prevent the occupying power from exploiting the ore mines and to making full use of the existing plants for war purposes, or because the workers who had been working in these enterprises joined the Army of National Liberation.

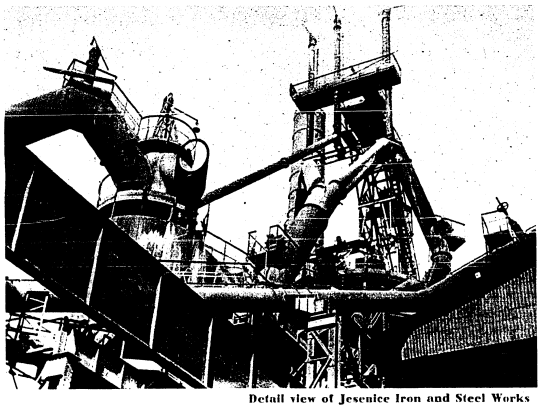
Post-war reconstruction and new construction

Immediately after the war, from 1945 till the end of 1946, repairs and reconstruction of damaged plants were undertaken at a forced tempo. The Ljubija iron ore mines were especially badly damaged, so that their productive capacity fell to only about 30% of prewar output. In the iron and steel plant of Zenica, the rolling-mill for structural shapes was seriously damaged, while the iron and steel plant of Vareš was also partially damaged. Difficulties arose also in regard to filling the vacancies in personnel with the necessary number of experts and skilled workers. In the case of the iron and steel plant of Jesenice, for example, only 12% of the needed personnel were available after the war.

In spite of numerous difficulties, all the repairs and reconstructions in the steel and iron enterprises were completed by the end of 1946. Production in 1947 had already passed that of 1939 and was able to supply the most urgently needed steel and iron materials for the reconstruction of enterprises in industry, transport, and other branches of the economy destroyed during the war, as well as materials for the repairs and reconstruction of damaged and destroyed houses and public buildings.

Since 1947 the expansion of existing and the erection of new ferrous metallurgy plants has been carried on in order to ensure the production of essential supplies of iron and steel needed for the greatly developed industrial production. As a first step intense prospecting was undertaken in order to discover adequate reserves of ore on which the further development of ferrous metallurgy depends. Prospecting was done both near the existing iron and manganese ore mines as well as in areas known to have ore deposits, in order to discover new deposits and to ascertain the amount of reserves available. Parallel with this, exploration was carried out for other raw materials necessary for the production of iron and steel. In a relatively short time, an increase was achieved in the production of coal needed for gasification in gas generators, and for fuelling open-hearth and other industrial furnaces. Prospecting for chromite, magnesite, and clays brought good results. It was possible, on the basis of the reserves discovered, to begin erecting big plants for the production of all kinds of refractory materials which are now produced in such quantities, that the needs of the ferrous metallurgy are fully met. Construction was also undertaken of new plants for the production of important ferro-alloys, using domestic raw materials. Ferro-manganese will also be produced in the future, in part from imported raw material. The electric power generating system, with great reserves of water-power at its disposal, is able to supply in full the needs of ferrous metallurgy. Large new hydro-electric plants have been built and their production supplemented by that of new thermo-electric power stations, which consume chiefly waste coal from the big mines.





Detail view of Jesenice Iron and Steel Works

Within the ferrous metallurgy enterprises all necessary auxiliary plants have been erected, such as those for the production of rolls for rolling mills of every kind, and the production of sufficient quantities of moulds and other materials for castings, while auxiliary hydro-electric and thermo-electric generators have been erected, the latter using chiefly waste gases from blast furnaces.

After the war, new coking plants have been built, together with by-product factories, which further contribute to the production of ferrous metallurgy. Coke is still produced from imported coal but, experiments are being carried on with various mixtures of domestic coal, with a view to producing coke in the future by using the largest measure possible of domestic raw material.

The erection of new auxiliaries and departments in existing and new iron and steel plants has been made to correspond to the needs of all the other industries in the country. Owing to the fact that sufficient quantities of scrap iron are not available in the country, because pre-war industry was not developed and because iron and steel were consumed only in small quantities in pre-war years, production of steel in Yugoslavia is based on using proportionally larger percentage of pig iron. For this reason it has been necessary to build blast furnaces with larger capacity compared to capacities for producing crude steel. In connection with this new iron ore mines had to be opened at Vareš in order that the production of iron ore might be adequate to supply the needs of the growing production of pig iron.

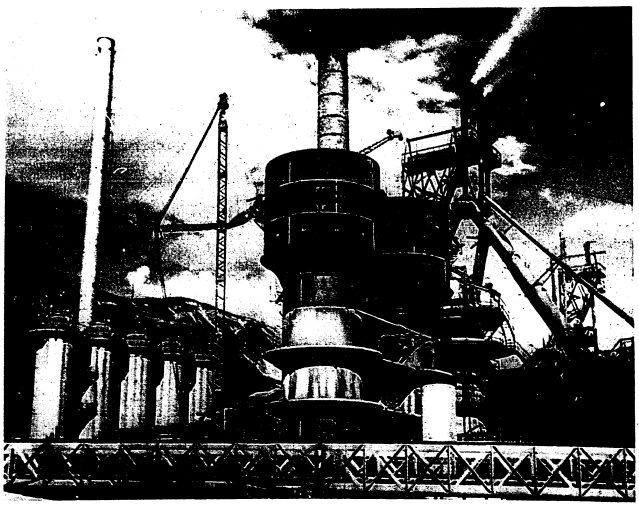
To reduce the cost of production as much as possible, it was necessary, while building new plants, to choose the most

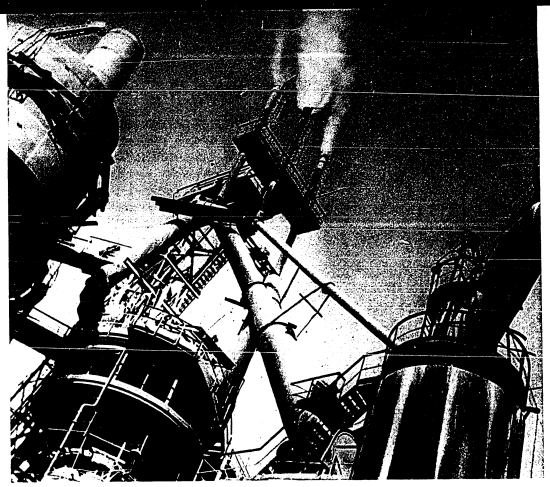
modern designs and productions processes with maximum of mechanization and automatic controls together with the construction of the largest possible productive units in order to achieve the highest productivity of labour.

Taking into account the necessity of increasing the production capacity of ferrous metallurgy as rapidly as possible new capacities and processes had to be restricted chiefly to the expansion of the already existing enterprises and to the erection of new shops and department inside the existing enterprises.

The greatest share in the construction of new capacities and new departments was carried out in the iron and steel plant of Zenica. This choice was justified, in view of the fact that Zenica is situated in the center of Yugoslavia, in the immediate vicinity of the Vareš ore mines, and in the centre of middle Bosnian coal basin, the Kakanj, Zenica and Breza mines. Its location on the Bosna River, and in view of the circumstance that it is connected by a wide net-work of long distance power transmission lines, with the big hydro-electric power stations of Jablanica, Jajce and Zvornik, and with the thermo-electric power Stations of Zenica and Kakanj were additional factors for its choice. The new Samac—Sarajevo railway line connects Zenica with all consuming centres.

Jesenice Iron and Steel Works



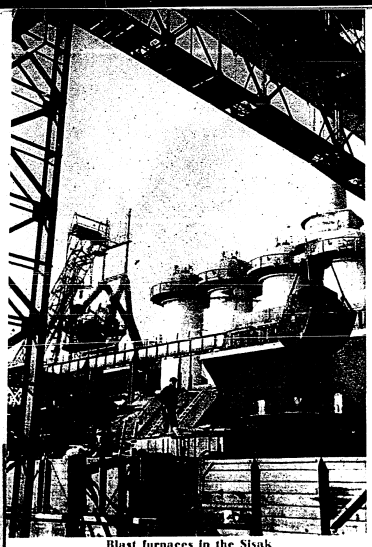


Detail from the Jesenice Iron and Steel Works

The iron and steel plant of Zenica produces everything, from coke to finished rolled products. Three batteries of the new coke ovens, with an annual capacity of 465,000 tons of coke are already in operation while a fourth battery with annual capacity of 155,000 tons will begin producing in 1956. Beside the coke plant the necessary plants for the production of ammonia-sulphate and all the other by-products consumed by other industries, especially by chemical industries have been erected. The coke plant uses waste gases from blast furnaces as fuel, while all its high grade coke gasses will be used for fuelling the open-hearth and other furnaces of Zenica.

Two up-to-date blast furnaces produce pig iron. All the necessary auxiliary installations for unloading, storing, transport, grading, and preparing the ore and coke have been erected. Beside the installation for mixing ore, coke, lime, etc. for charging the furnaces, a plant for the agglomeration of ore has been erected, thus decreasing the consumption of coke, and at the same time effecting a rise in the output of the blast furnaces. Connected with the furnaces is a power plant with the necessary number of steam boilers and blowers, together with a plant for collecting, purifying and distributing waste gases from the blast furnaces, which are fully utilized only in the Zenica plant. The capacity of the two blast furnaces already working amounts to about 400,000 tons of pig iron annually. The third furnace, with a capacity of 200,000 tons, is under construction.

Near the smaller open-hearth furnaces of the old plant with their combined capacity of 80,000 tons, a new steel making plant has been erected, with new 60 ton capacity stationary open-hearth furnaces and big tilted open-hearth furnaces of 180 tons, having a total capacity of 440,000 tons, are already operating. Other tilted furnaces of 180 ton capacity are in construction, so that the capacity of the iron and steel plant of Zenica will soon be 700,000 tons of open-hearth steel annually.



Blast furnaces in the Sisak Iron and Steel Works

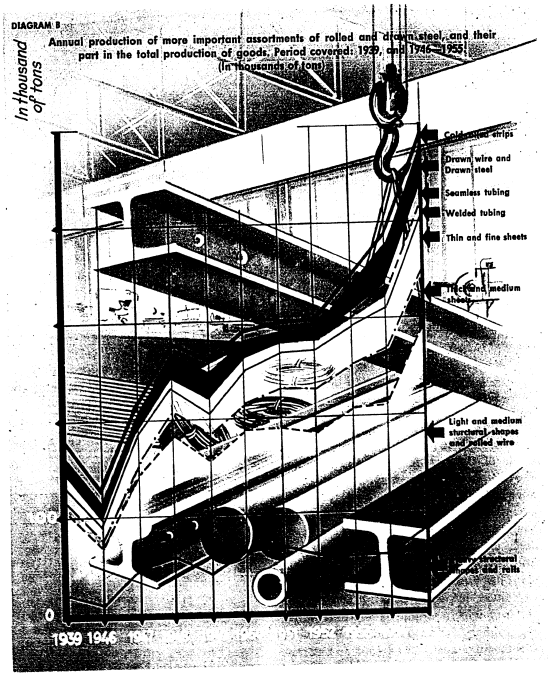
Besides open-hearth steel, about 50,000 tons of electro-steel will be produced annually, 13,000 tons of which are already being produced.

All the crude steel will be processed in Zenica's own rolling mills chiefly to produce commercial goods in great demand. Beside the old reconstructed rolling mill of prewar days, a new blooming mill has been built, so that the total capacity for rolling heavy semi-finished products comes up to about 700,000 tons of ingots annually. On the finishing ways it will be possible to roll about 500,000 tons of heavy structural shapes, railway rails, medium, light or fine structural shapes, concrete reinforcing rods, beams, and drawn wire. All the rolling-mills except the medium and the wire mill, are producing already, while the construction of the other mills will be finished during 1956. In addition to the rolling-mills Zenica has an up-to-date heavy forging shop equipped with steam power hammers and forging presses with pressures of up to 1,850 tons. The construction of a press with 5,100 tons of pressure will soon be finished, as well as a rolling-mill for bands. The productive capacity of the forge shop will be about 20,000 tons of heavy forgings and car-wheel accessories, to supply the needs of railways, other vehicles of transport, and the needs of ship-building and machine construction plants.

The iron and steel plant of Sisak receives its iron ore from the neighbouring Ljubija mines, and from its own small iron ore mines. In addition to the old small furnaces, new blast furnaces have been erected, designed by the enterprise itself and manufactured by domestic machine construction factories, so that the plant has a total output of about 140,000 tons of pig iron annually. Near the blast furnaces an installation for mixing iron ore and coke, a furnace for sintering ore, a power station, and a plant for purifying and distributing waste gases from the furnaces have been erected. In the newly built section of the plant, open-hearth furnaces are working, with an annual capacity of about 100,000 tons of steel while in the newly erected rolling-mill for seamless tubes, the crude steel produced by the enterprise itself is processed to make tubes and tubing of dimensions ranging from the smallest to about 400 mm Ø. The total output of the rolling-mill is about 60,000 tons of seamless tubing annually. The Sisak iron and steel enterprise will produce tubing and piping needed by the steam-boiler factories and especially by the oil industry. Shops and departments for alkali — treatment, galvanizing, bitumen-coating, and drawing of tubes will soon be completed.

At the iron and steel plant of Jesenice, blast furnaces with an annual capacity of about 140,000 tons of pig iron are working. Approximately 240,000 tons of crude steel are produced annually in the open-hearth furnaces with individual capacities of up to 60 tons. Electric furnaces with an annual capacity of 10,000 tons of steel are also operating. All the crude steel is processed in the plant's rolling mills. The rolling mills produce only about 15,000 tons of structural shapes, while the remaining steel is rolled into thick, medium, thin and fine sheets and cold-rolled strips, welded tubing, and drawn wire. It also produces all kinds of medium and high alloyed steels, and patent wire needed by machine construction plants and building enterprises.

The iron and steel plant of Store produces annually up to 20,000 tons of special



pig iron in electric furnaces for its own open-hearth furnaces and its foundry for cast iron pipes, moulds, and rolls. In addition it produces 30,000 tons of crude steel annually which is then processed in the plant's own rolling mill into medium, light, and fine structural steel.

At the Ravne iron and steel plant which produces special types of complicated steel castings and various forgings from high-grade and alloyed steel, the productive capacity of the existing open-hearth furnaces, of the electric arc furnaces, and high-frequency electric furnaces reaches about 50,000 tons of crude steel annually. Of the ferrous metallurgy products, up to 4,000 tons of alloyed rolled and tool steels are produced annually and approximately 10,000 tons of forged small beams and rods.

At the iron and steel plant in Smederevo, the productive capacity of the existing open-hearth furnaces and the electric furnaces comes up to approximately 47,000 tons of crude steel. The plant processes its own steel, and uses steel from other steel plants to produce thin, fine, black, decapated or galvanized sheets. It also rolls semi-finished products for its own forge and pressing plant, and for the sheet rolling-mills of Zemun.

Near the iron and steel plant of Zenica, with which they are connected by a standard gauge railway line, are the Vareš iron ore mines and iron and steel enterprise. The mines already have an output of over 1,300,000 tons of iron ore for the needs of its own furnaces and of other steel mills in the country. The ore contains mainly siderite, limonite, and some hematite. Its outstanding feature is that it has a considerable percentage of manganese, the ratio between manganese and iron content of the ore being 1 : 10. The plant has two blast furnaces working, with an annual output of about 70,000 tons of pig iron which supplies the needs of its own foundry for producing cast iron pipes and machine castings as well as pig iron for other foundries in the country.

The best and most reductive iron ore (limonite and siderite) in the country is mined in the Ljubija mines which produce 600,000 tons annually for the iron and steel plants of the North-Eastern part of the country and in part for the Zenica blast furnaces.

There is also a number of small mines in the country. An additional source of iron is the roasting residue with iron content from the processing of pyrite and pyrrhotine into sulphuric acid, and from the production of alumina out of bauxite in the aluminium industry.

Reconstruction work done in the first few years after the war, and the gradual erection of new plants since 1948, have made possible the continuous growth of production in post-war years especially after 1952, following a brief pause between 1949 and 1952. A big rise in the production of finished steel products in recent years was made possible, above all, by the erection of new rolling-mills which make possible a fuller and better use of steel plants erected in the earlier years.

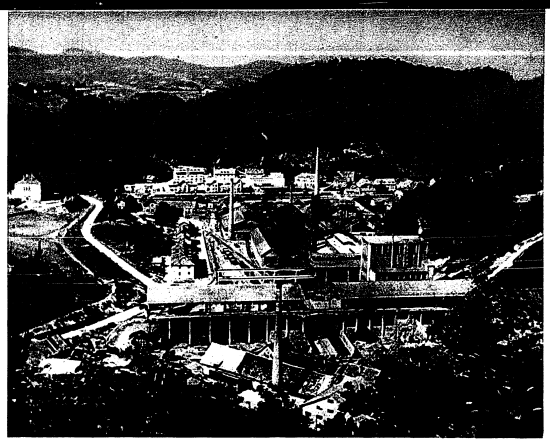
Results

How production developed from year to year can be seen from the appended Diagram A and from the following table:

A) The production of iron ore, in tons

in tons
Index 100 = 1939

Year	Production	Index
1939	666,813	100
1946	398,607	59
1947	739,382	111
1948	878,493	132
1949	833,213	125
1950	730,866	110
1951	581,518	88
1952	676,010	101
1953	794,917	120
1954	1,110,743	167
1955	1,398,298	210



Store Iron and Steel Works

The table shows that prewar ore production was relatively large compared to the production of pig iron in the country during the same year because about two thirds of the ore produced was exported. Such was also the case with the production of iron ore between 1947 and 1951, when ore production was above the amount the country needed for the production of pig iron. From 1951 onwards the production of ore went on more or less in proportion to the domestic production of pig iron.

B) The production of pig iron

(in 1000 tons)
(See diagram A) Index 100 = 1939

Year	White pig iron	Gray pig iron	Total	Index
1939	90	11	101	100
1946	75	9	84	83
1947	139	23	162	160
1948	147	25	172	170
1949	158	32	190	188
1950	185	27	212	210
1951	223	25	248	246
1952	252	21	273	270
1953	233	37	270	267
1954	331	25	336	332
1955	465	49	514	510

The rise in production in 1947 and 1948 is to be attributed to the more efficient utilization of the blast furnaces erected before the war, and to lesser reconstruction work in existing plants. From 1949 onwards, the production of pig iron has been constantly rising owing to the increasing use of newly constructed small blast furnaces, while the big rise in production after 1954 is due to new modern blast furnaces which began operating in the iron and steel plant of Zenica.

C) The production of crude steel

(in 1000 tons)
(See diagram A) Index 100 = 1939

Year	Open-hearth steel	Electro-steel	Total	Index
1939	232	2.8	234.8	100
1946	201	0.5	201.5	86
1947	306	5.2	311.2	133
1948	358	10.4	368.4	157
1949	387	13.6	400.6	170
1950	414	14.0	428.0	182
1951	420	14.3	434.3	185
1952	425	17.0	442.0	188
1953	495	20.3	515.3	219
1954	588	28.0	616.0	262
1955	759	46.0	805.0	340

The above table shows the steady rise of the production of crude steel until in 1955 when the openhearth steel production was 227% of the 1939 figure and electrosteel production 1,640% of 1939. Because of specific conditions in the country resulting in the shortage of scrap iron the proportion of pig iron in the open-hearth furnaces had to be somewhat bigger than usual. This can be seen best by comparing the amount of white pig iron produced with the amount of open-hearth steel produced, the ratio being 90:232 or 0.387 in 1939, while in 1955 it was 465:759 or 0.612.

D) The production of rolled, drawn and forged steel

(in 1000 tons)

— without castings and processed forgings — (According to »Index« an official publication of the Federal Bureau of Statistics and Records)

(See diagram A) Index 100 = 1939

Year	Rolled products	Drawn products	Forged products	Total	Index
1939	151	2.5	0.4	153.9	100
1946	112	0.2	0.5	112.7	74
1947	191	8.2	0.6	199.8	127
1948	247	11.4	0.2	258.6	164
1949	250	13.2	1.2	263.4	167
1950	278	11.9	1.2	291.1	184
1951	301	13.6	2.0	316.6	201
1952	293	11.8	4.1	308.9	196
1953	320	13.8	4.8	338.6	214
1954	411	19.2	8.0	438.2	278
1955	494	28.1	17.0	539.1	340

In reality, the quantity of steel products was larger, if the production of foundry castings and other semi-finished products are taken into account, which has not been done here because these are processed in plants outside of the ferrous metallurgy category, or abroad. Taking them into account, the total production would be as given in the above table (according to principles of statistics set down by the U. N. Steel Commission in Geneva):

(in 1000 tons)	1951	1952	1953	1954
Railway rails and accessories	42.0	44.9	39.1	47.6
Heavy construction shapes	69.6	30.5	40.0	106.0
Medium and light construction shapes	115.1	125.2	111.4	117.1
Rolled wire	25.2	21.9	27.6	41.4
Hot-rolled strips	19.5	11.7	7.3	7.0
Thick and medium sheets over 3 mm thick	26.4	37.7	46.1	44.9
Other products	—	—	25.4	34.5
Finished steel forgings	9.2	10.5	10.7	12.3
Forged small beams and rods	2.0	4.1	4.8	8.0
Total production of hot-rolled, forged and foundried steel products	353.8	335.6	375.4	491.2

Ravne Iron and Steel Works

The rise in production of certain assortments of goods from year to year can be seen from Diagram B, which shows the gradual structural change in the whole production of steel and iron goods, as regards various chief assortments.

The tempo of increase of ferrous metallurgy production in Yugoslavia in the post-war period was greater than in the other countries of Europe, but the fact remains that the production of steel per capita is still behind that of other countries, especially the highly industrialized countries. While in 1939 the production of crude steel in Yugoslavia amounted to approximately 15 kg per inhabitant and the consumption to 26 kg per capita, in 1955 the production already reached about 46 kg, and the consumption 53.7 kg per capita. In Europe (without U. S. S. R.) over 200 kg of crude steel are produced per capita while in the world the figure is coming close to 100 kg per capita.

Future prospects

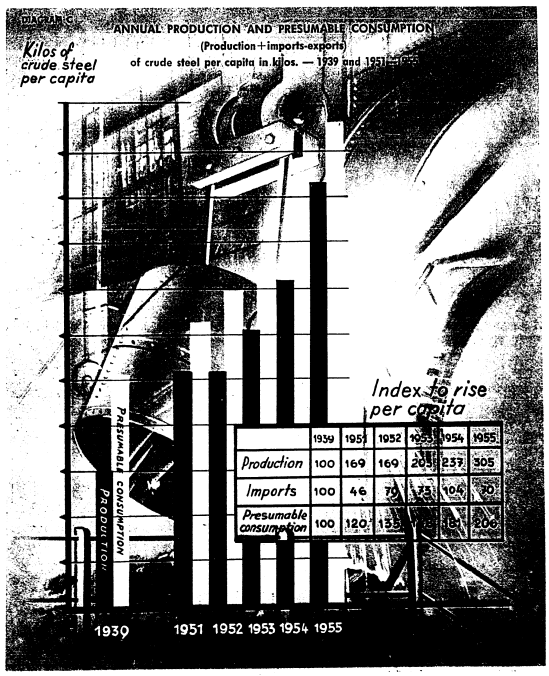
Serious attention will also be given in the future to the further development of ferrous metallurgy, within limits set by available raw materials. Considerable new plants have already been erected which began operating in 1955, while other new plants, now in construction, will be completed during the next few years. When all these new plants shall have been completed the capacity of ferrous metallurgy industry will be close to 1 million tons of iron ore and over 1,350,000 tons of crude steel annually. This entire production will be processed for rolled, drawn, and forged goods and foundry castings. With the above foreseen increased capacity the production of crude steel will in the near future rise as high as 70 kg per capita. There is going to be an increase especially in the production of alloyed steels since sufficient and cheap hydro-electric power and domestic raw material for ferro-alloys (excepting nickel) are available. With the rise of

Vareš Iron and Steel Works

capacity in the rolling-mill and increase in the manufacture of various kinds of sheets and strips. the disproportion between the production of rolled goods compared to the total production of steel, will, to a certain degree, be done away with.

Owing to the fact that there has been a growing demand for rolled steel in post-war years, and because overall industrial production has developed very rapidly, it has been necessary to import considerable quantities of rolled goods, especially sheets, strips, wire, and alloyed steel, in spite of a considerable rise in production of domestic ferrous metallurgy enterprises. Up to as recently as 1954, large quantities of gray pig iron were imported. And owing to insufficient quantities of scrap iron from the steel making plants and that collected in the country during scrap collecting campaigns, scrap had to be imported from abroad. Up to the end of 1952, all the coke necessary for the production of pig iron and for the foundries was imported. From 1952 onwards gradually, more and more, coke was being produced in the country in the newly erected coking plants so that today only coking coal for coke manufacture is imported.

In the future, the import of raw materials necessary for ferrous metallurgy production will decline. Imported coking coal will be partly and gradually substituted by domestic coal with which it will be



	1939	1951	1952	1953	1954	1955
Production	100	169	169	205	237	305
Imports	100	46	70	135	104	70
Presumable consumption	100	120	135	161	186	206

The products of the Sisak Iron and Steel works

mixed to manufacture domestic coke, a process that has proved successful in experiments. With the growth of domestic industrial production, the import of scrap will go down, though it will still be necessary to import a certain amount. The import of refractory materials will be limited to special kinds of bricks, the production of which is not economically practicable in the country, while the import of some kinds of rolled materials, especially special kinds of structural shapes and some other assortments, will be necessary even after all the planned new plants are completed, as the need for these materials will be greater than the possible output of domestic plants, and as domestic production will include only those products for which there are domestic raw materials and conditions making economically sound production possible. Owing to the erection of new plants for the production of pig iron, there is no more need to import gray pig iron for the foundries. Only special types of pig iron, for special purposes, will be imported.

Import and export of ferrous metallurgy products in the period between 1951 and 1954 compared to 1938, was as follows:

(in 1000 tons)

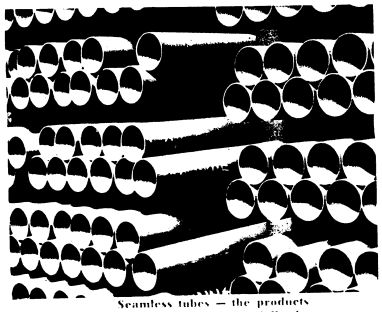
	1938	1951	1952	1953	1954
Imports					
Coke	241	485	466	240*	218*
Scrap iron	35	13	22	4	76
Pig iron	16	21	18	12	29
Crude steel and semi-finished products	14	—	3	5	—
Rolled steel	55	61	102	101	143
Exports					
Iron ore (including pyritic burns)	388	283	165	25	16
Ferro-alloys	7	6	5	5	4
Rolled material	—	—	—	1	2

* Instead of coke, more and more coking coal is imported.

Organization of import and export

Ferrous metallurgy enterprises have their association in Beograd, »The Yugoslav Association of Iron and Steel Plants«, which, besides purely professional work, gathers information about domestic and foreign markets, about the needs of consumers, and gives data and its opinion on these matters to the Chamber of Foreign Trade.

The Chamber of Foreign Trade of Yugoslavia with its head offices in Beograd conducts all arrangements and operations

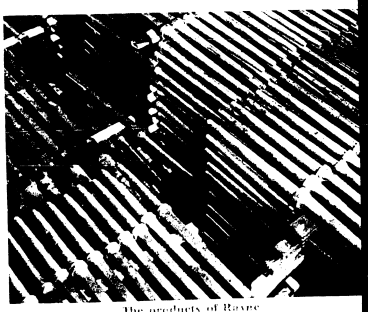


Seamless tubes — the products of Sisak Iron and Steel Works

connected with the import and export of goods. All Yugoslav importers and exporters, and representatives of foreign firms in Yugoslavia are members of the Chamber. It has sections, in the work of which interested importing and exporting enterprises take part.

The enterprises importing and exporting ferrous metallurgy products are members of the 12 following section:

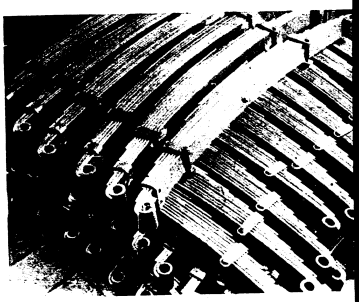
»TEHNOPROMET« — Beograd,
»FERIMPORT« — Zagreb, and

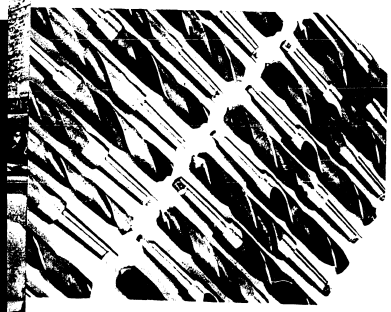


The products of Ravne Iron and Steel Works

»METALPRODUKT« — Zagreb, — all three of which are engaged in importing and exporting all ferrous metallurgy product;

»ŽELJPOH« — Zagreb,
»GVOŽĐAR« — Novi Sad, and
»METAL« — Sarajevo, — all the of which are engaged in supplying the do-

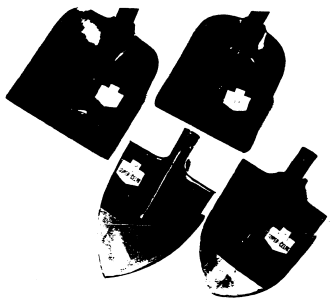




mestic commercial enterprises with imported ferrous metallurgy products, mainly consumers goods;

KOVINOTEHNA — Celje,
METALURGIJA — Beograd, and
INDUSTROTEHNA — Zagreb, — all importing high grade steel;

The products of Smederevo Iron and Steel Works



BRODOIMPEKS — Beograd, and
BRODOMATERIJAL — Rijeka, — which import steel products for the shipbuilding industry;

KUGLEKS — Beograd — which imports steel for the manufacture of ball bearings.

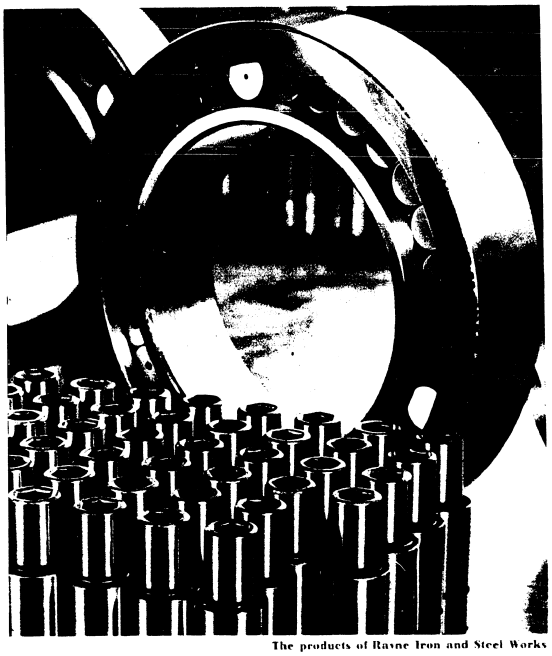
Twenty-two foreign enterprises are members of the section of representatives of foreign firms of the Chamber of Foreign Trade, and these represent 31 European and Canadian firms which produce either ferrous metallurgy product in general or only special rolled and drawn steel products. All these enterprises in addition to their headquarters staff, usually have their representatives at their warehouses, larger consuming centres, or at seaports, depending on the specific nature of their business. The following enterprises represent foreign firms:

In Beograd:

ADRIA,
BALKANIJA,
DINARA,
ČELIK,
INDUSTRIA-IMPORT,
JUGOMONTANA,
JADRAN,
CONTINENTAL,
KONTAKTOR,
MAŠINOKOMERC,
OMNIKOMERC,
PROGRES,
RAPID,
STANDARD and
UNIVERZAL;

In Zagreb

CENTRALCOMMERCE,
GENERALCOMMERCE and
MERKUR;



The products of Ravne Iron and Steel Works

In Ljubljana

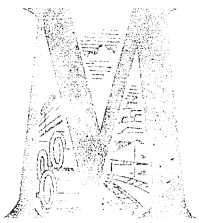
HERMES,
TEHNOMETAL and
KONIM;

In Rijeka

DELTA.

Through The Yugoslav Association of Iron and Steel Plants Yugoslavia keeps in touch with similar associations abroad, and takes part in the work of the Steel Commission of the U. N. Economic Commission for Europe in Geneva. Since 1955 Yugoslavia has a permanent delegate with the Organization for Economic Cooperation in Europe (OEEC) in Paris.

Steel Works



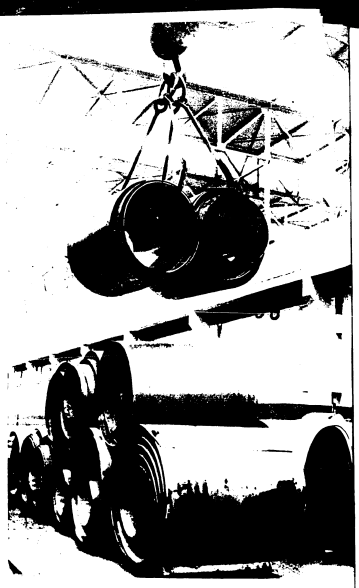
any ancient mines, the remnants of tools of old, as well as preserved written documents, bear witness to very intensive mining activities on Yugoslav territory as far back as the Roman era and the Middle Ages. Most of the mineral and metal ore deposits of today have been opened up where traces of mining of old were found. Gold, silver and lead were used in the remote past to coin money, to make arms, and for purposes of decoration. The rulers and nobles of mediaeval Serbia made use of these natural riches of the country to further the development of their states and to contribute to their economic power. Many towns were built in the Middle Ages in the neighbourhood of the mines of those days. Towns like Novo Brdo, Srebrenica, and Olovo were known far and wide at the time. Novo Brdo of mediaeval times, for instance, had more than 30,000 inhabitants, and it was one of the big towns of the Balkan Peninsula. With the Turkish invasion and the downfall of the Serbian State, in 1389, the mining of nonferrous metals gradually comes to an end. On territory which did not come under the domination of the Turks mining continued developing. The fact that mercury mines in Idria never stopped working from 1500 until this day, illustrates this point.

The exploitation of nonferrous metal mines begins to develop considerably only at the turn of the century. (The discovery of the Bor copper mine in 1903, the opening up of the Trepča lead and zinc mines in 1923 etc.)

Owing to the rich deposits of ores of nonferrous metals on her territory and to the interest shown by foreign capital for them, Yugoslavia was well-known even before World War II for her big production of non-ferrous metals.

Yugoslavia was the biggest producer of copper in Europe. She took second place in Europe in the production of lead, producing 26% of Europe's total production. Together with the Yugoslav part of Istria, Yugoslavia was first in the production of bauxite, accounting for over 32% of Europe's total output.

DEVELOPMENT OF THE NONFERROUS METALLURGY



Copper Rolling Mills, Sevojno

She was also the biggest producer of antimony, and of silver, present in the various ores mined.

Besides these metals, which play a conspicuous part in European production, Yugoslavia has been producing mercury (in Istria), zinc, gold, chrome ore, manganese ore, pyrite ore, and pyrite concentrates, and other metals.

Nonferrous metallurgy in Yugoslavia includes:

The production of all nonferrous metals, except iron ore, namely: copper, lead and zinc, bauxite, antimony, mercury, gold, tungsten, chrome, manganese, pyrites.

The refining of ores of nonferrous metals, viz. copper, lead, and zinc, antimony, chrome, pyrites, tungsten and gold, by means of separating methods and by means of flotation processes.

Owing to the magnitude and variety of production of nonferrous metals, nonferrous metallurgy was, before World War II, and compared to other branches of extractive industries, by far the most developed.

Yielding first place only to agriculture and the forest products industries, nonferrous metals have been one of the most developed branches of the country's economy in value and importance of their production.

A sure sign of the value of nonferrous metals and the good business opportunities they offered before the war is the fact that, owing to the policy adopted by Yugoslavia of those days, 92% of the total output (reckoned at its money value) was in the hands of foreign capitalists.

In pre-war Yugoslavia, the exploitation of mines of nonferrous metals was semi-colonial in character. Ores and concentrates were produced, and were exported abroad, where they were dressed and refined into metals, rolled goods and other semi-finished products, so that all the finished goods of high value were produced abroad. For instance, in 1939, out of 93,316 tons of lead concentrate, from which 68,000 tons of lead can be obtained, only 10,651 tons of lead were produced in the country. Out of 78,624 tons of zinc concentrate from which over 31,000 tons of zinc could have been refined, but only 4,642 tons of zinc were produced. The production of crude blister copper amounted to 41,643 tons in 1939 of which only 12,463 tons of electrolytic copper were produced in the country, while the balance was exported as blister copper. The case with rolled copper and aluminium rolled products was much the same. Thus in 1939 only 4,519 tons of rolled copper and copper alloy goods were produced, and only 15 tons of rolled aluminium goods. In spite of rich reserves of these ores, rolled goods had to be imported.

A further feature of pre-war production was the very small use made of by-products of the metal smelting and refining processes. Such was the case with sulphur, although the gases from the Bor smelter of copper contained enough sulphur to produce from 160,000 to 200,000 tons of sulphuric acid annually.

The care of ore reserves of nonferrous metals was left in pre-war Yugoslavia chiefly to foreign companies. There was no central geological organization for prospecting for nonferrous metals. Further prospecting in mines which had already been opened depended chiefly on market prices and on the world political situation.

With the exception of a few (Trepča Mežiec), the mines had little mechanized equipment (Bor, Idria, Blagojev Kamen, and other mines), because wages were low.

Domestic consumption of nonferrous metals amounted to little, as the general level of industrial production was very low. Thus, for instance, only about 7,000 tons of copper, 2,000 tons of lead, less than 2,000 tons of zinc, and approximately 1,000 tons of aluminium were consumed in the country.

During the last war the mineral reserves of the operating mines were mercilessly exhausted, so much so, in fact, that several mines, such as the antimony and chrome mines, were left, at the end of the war, practically without any reserves. In our biggest mines of nonferrous metals, Trepča and Bor, no prospecting, nor even preparatory work, was done.

During the war, many of the mines were seriously damaged, and some of them completely ruined (Kopaonik, Lece, and Blagojev Kamen, for instance).

The production of alumina and gold by means of cyanidation.

Smelters of copper, lead, zinc, antimony, mercury, and bismuth.

Refineries of lead, zinc, and antimony.

Electrolysis of copper, zinc, aluminium, silver, and gold.

Copper, aluminium, lead, and zinc rolling mills.

Ferro-alloy factories producing: ferro-manganese, sylico-manganese, ferro-chrome, ferro-sylicon, and precious ferro-alloys.

In short, after the war, nonferrous metal mines were found in a state of exhausted ore reserves, many of them without any reserves at all, and almost all of them without geologists, since geology before the war, was in the hands of foreigners. After the war, there was neither a sufficient number of engineers, nor highly skilled workers, as foreign engineers left our country, while a great many workers, and a substantial part of the technically skilled personnel, lost their lives in the national liberation war.

Owing to war conditions, erected plants and equipment were not properly maintained, and many of them were damaged (Bor, Trepča, and other mines).

If we add to this the insufficiently developed technical basis (the metal processing and electro-industry, the unmechanized buildings and plants) which had been left after the war in Yugoslavia, a fuller picture will be had of the conditions in which post-war construction and the production of nonferrous metals have been developing in Yugoslavia.

Post-war development

Special attention has been given to the development of nonferrous metallurgy, as one of the chief branches of basic industry. This will be seen further on, in the brief description of the newly erected plants and of the expansion of those which were in existence at the end of the last world war. Besides great resources of the country, which were invested in the development of ore reserves and the erection of mines and plants of nonferrous metals, it should be pointed out that foreign loans have contributed considerably to this development. A loan from the Export-Import Bank (U. S. A.) was used to acquire equipment for mines of nonferrous metals, as well as equipment for new lead and zinc flotations, for the separation of antimony and tungsten, for the cyanidation of gold, and so on. The loan from the International Bank has been used to buy equipment for completing certain projects and for the erection of new plants as, for instance, the copper and zinc electrolysis works in Sabac, the alumina and aluminium factory at Kidričevo, the cable factory of Svetozarevo, and others. The loan from Western Germany was used to buy equipment for the copper and copper alloy rolling-mills at Sevojno, and so on.

The policy regarding the development and utilizing of nonferrous metals in the post-war development of nonferrous metallurgy in Yugoslavia can be summed up as follows:

The increase and the expansion of ore reserves, which in fact made the further increase in production possible.

The continual increase in the total output.

Exploitation of low-grade ores in the way that is done in highly industrialized countries.

Erection of new and expansion of existing plants for processing ores and concentrates, in order to get products of greater value.

Expansion of metal smelters and refineries, in order to get greater quantities of metal.

Erection of new rolling-mills for nonferrous metals and the expansion of those existing, as well as of ferro-alloy factories, so as to satisfy the country's needs, and to export semi-finished and finished products instead of ores and crude metals.

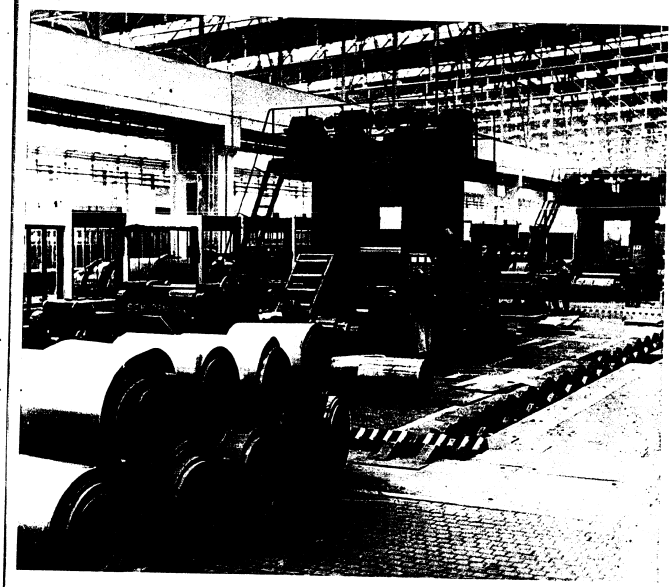
The production of new metals and new products.

A fuller use of ore reserves to get certain by-products during dressing of basic ores.

A gradual increase in domestic consumption, in quantity, as well as in the variety of assortments.

To play a very considerable part in the total export of Yugoslavia.

To introduce ever more mechanization in mining and ore processing plants.



Detail of the copper cold rolling mills at Sevojno

An increase especially of late years, of engineers, and graduates of technical schools, all educated in domestic universities and higher schools. An ever more constant number of workers.

Production

The increase in the total output is shown in Diagram 1, which is based on data from the Federal Bureau of Statistics and Records, and it shows that the pre-war level of production (1939) was reached again in 1948, and that since then it has been going up constantly. And it can also be seen from the diagram that the increase in the total industrial output is greater than in that of nonferrous metallurgy. This is because, as has already been pointed out, nonferrous metallurgy was one of the most developed branches of economy before the war. This increase in output was achieved mainly due to the increase in the ore-reserves mined, and, in connection with this, to the opening of new

mines and the erection of new and the expansion of old plants.

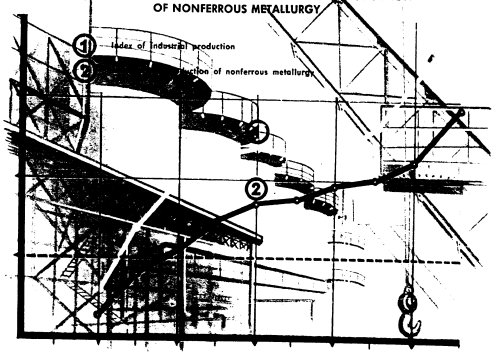
As can be seen from the tables given for some metals, the level of production went up in the post-war period, as compared with pre-war production, for all products except copper. For the last four years the production of copper is below pre-war level by about 10,000 tons annually. This fall in output is due, as will be seen later, to the fact that the ore mined contains less and less copper. The prewar level of production of bauxite has been reached, and surpassed only in 1955. The main reason why the former level of bauxite production was not reached before lay in unfavourable conditions on the market abroad and, up to 1954, in the very small amount consumed by the domestic market.

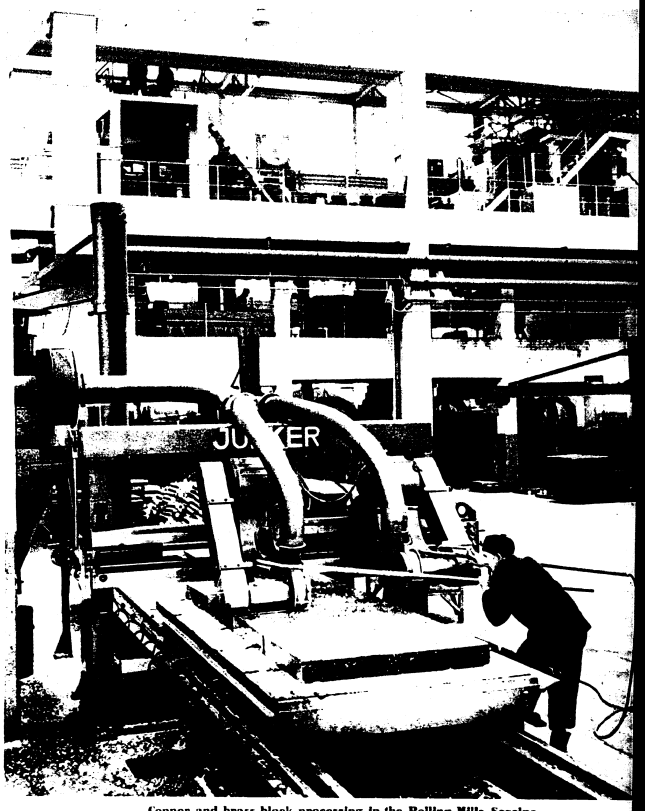
One of the main features of production has been the ever-growing processing of concentrates and refining of crude metals in the country. Thus, for example, and thanks to the expansion of the Trepča smelter in 1951, the whole output of lead concentrate has been processed in our country since then. The country's whole output of crude copper is being refined in our country ever since 1953, the year in which the copper electrolytic plant of the Bor mine was enlarged. This policy of completing ever greater quantities of finished products, will be continued in the future. Early in 1956, a new zinc electrolytic plant will start working, dressing zinc concentrate, so that zinc as a finished product will be exported, instead of its concentrate. It is much the same case with aluminium.

By processing ores and concentrates in the country to an ever greater degree, not only greater quantities of basic metals

DIAGRAM 1

INDEX SHOWING INDUSTRIAL PRODUCTION AND PRODUCTION OF NONFERROUS METALLURGY





Copper and brass block processing in the Rolling Mills, Sevojno

have been obtained, but byproducts as well, such as silver, gold, bismuth, cadmium, selenium, sulphur.

A most important feature of present day production of nonferrous metals, as compared to pre-war production, is the success achieved in erecting new plants and expanding old ones, in the production of rolled goods of copper and its alloys, of aluminium and its alloys, and of lead and zinc. Newly erected plants of a very considerable productive capacity, most of them having begun production in 1954 (copper and copper alloy rolling-mills at Sevojno, the cable factory in Svetozarevo, the Industry of semi-finished metal products at Slovenska Bistrica), as well as those which started work in 1955 (light metals factory in Sibenik), are doing their share in giving the industry of nonferrous metals an ever growing processing character.

Thus we have succeeded, in this post-war period, in developing the production of a great many rolled products of copper and copper alloys, of aluminium and its alloys, of rolled copper, of tungsten concentates, of ferro-tungsten and ferro-molybdenum, of selenium and so on.

Consumption in the country

Nonferrous metallurgy has in an ever greater measure satisfied the country's needs for nonferrous metals and rolled products of nonferrous metals.

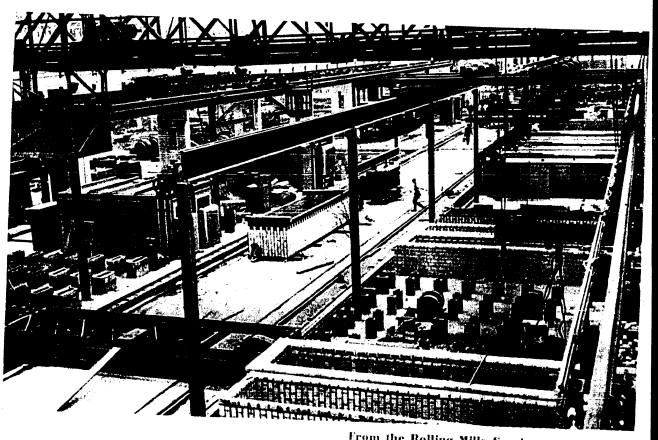
Of the basic metals Yugoslavia has imported tin, which she does not produce, and of the alloying metals, nickel, cobalt, molybdenum, and other metals, either in the form of metals, or in the form of ferro-alloys.

The domestic consumption of some of the more important nonferrous metals can be seen from the following table.

Domestic consumption of nonferrous metals

Year	In thousands of metric tons			In metric tons			
	Copper	Lead	Zinc	Aluminium	Mercury	Antimony	Tin and tin alloys**
1947*	16.0	6.6	4.9	--	8	155	--
1948*	14.6	7.8	6.5	--	38	255	--
1949*	16.8	7.3	8.2	--	70	327	--
1950*	18.8	7.2	10	--	23	276	--
1951	19.4	8.4	8.3	3.5	56	115	585
1952	14.8	5.2	5.5	4.6	23	211	388
1953	16.5	9.6	6.5	3.1	50	177	642
1954	19.3	9.6	10.1	4.7	90	352	455

* Data from »Mining and Metallurgy« № 1 1953.
** Imported.



From the Rolling Mills, Sevojno

Although domestic consumption shows a gradual rise, it is still very low, compared to that of highly industrialized countries. This can be seen if we compare the consumption, per capita, of some basic metals in 1953:

Consumption, in kilos, per capita, in 1953*

Country	Copper	Lead	Zinc	Aluminium
Austria	2.36	1.93	0.72	2.89
England	6.44	4.82	3.87	3.62
France	2.24	1.92	2.21	1.74
Italy	1.49	1.01	0.77	1.28
USA	6.75	4.47	5.53	8.76
USSR	1.65	1.00	1.10	1.38
Yugoslavia**	1.14	0.56	0.59	0.26

* Data on consumption of various countries in tons, taken from »Metallstatistik«, Frankfurt an Main.
** In 1954.

The very low consumption of aluminium strikes the eye. The reason for this is low domestic production up till as recently as 1955. The consumption of aluminium, owing to the rise in domestic production of this metal in 1955 and later, will rise more quickly than the consumption of other metals.

Export and import

Nonferrous metallurgy, in the period surveyed, took a very important place in the total export of Yugoslavia. Out of the total export in the period from 1946 to 1954, inclusively, amounting to 526 billion dinars ($ 1 = 300 dinars) nonferrous metallurgy claims over 104 billions, or nearly 20% (19.8%). Reckoned out in dollars, the total export of nonferrous metallurgy during these nine years comes to 348 million dollars.

Bor Copper Ore Mines

The following table shows the total exports of Yugoslavia and the total export of nonferrous metallurgy products from year to year, reckoned at prices f. o. b. the Yugoslav frontier, in clearance dinars.

The very high figure to which export rose in 1952 is due to the great demand for nonferrous metals at the time (Korean war).

In spite of the rise in domestic consumption, the export of nonferrous metallurgy products still goes up, owing to a planned rise in production, as well as owing to Yugoslavia's need to increase her exports.

The most important items in our export during the period surveyed were lead, copper, bauxite, mercury, silver (See diagram 2).

During these years our export has somewhat changed in its structure so that more finished and valuable products are gaining ground. Thus, for instance, lead concentrate is not exported since 1951, but refined lead in its stead. Blister copper is not exported since 1953, but electrolytic copper in its stead, and so on. Newly erected smelters and electrolytic plants have contributed toward this. The rise in the export of rolled goods in recent years has been modest. However, owing to the fact that the erection of big copper and aluminium rolling-mills has been completed recently the export of rolled goods has already gone up in 1955.

Exports from 1946 till 1955, inclusive*

In millions of clearance dinars ($1 = 300 dinars)

Year	Total Yugoslav exports	Total export of nonferrous metallurgy products	%
1946	16,462	4,689	28.5
1947	50,892	9,589	18.8
1948	90,988	12,092	13.3
1949	62,960	10,505	17.3
1950	47,580	9,998	20.0
1951	55,102	15,871	28.8
1952	73,958	17,409	23.6
1953	55,794	12,427	22.3
1954	72,113	11,624	16.1
1955	74,108	15,217	20.1

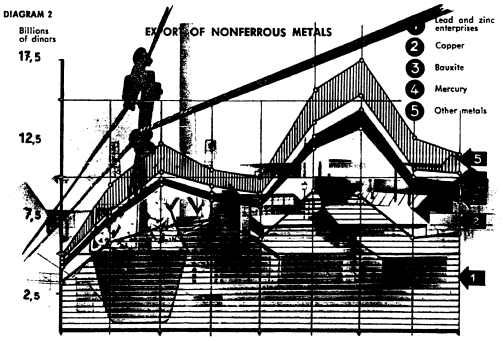
Imports from 1946 to 1955, inclusive

In millions of clearance dinars ($ 1 = 300 dinars)

Year	Total Yugoslav imports	Imports of nonferrous metals	%
1946	10,770	96	0.90
1947	50,819	399	0.78
1948	94,252	1,031	1.10
1949	90,814	930	1.03
1950	70,738	718	1.02
1951	117,242	968	0.83
1952	111,925	1,336	1.19
1953	118,591	1,114	0.94
1954	101,819	871	0.86
1955	129,478	1,228	0.96

* Data: The Federal Bureau of Statistics and Records — Statistics of Foreign Trade.

DIAGRAM 2



With the exception of certain temporary conditions, such as disposing of chrome ore and chrome concentrate in 1954, there have been no difficulties in finding markets for nonferrous metallurgy products. Owing to economic relations which Yugoslavia is increasingly developing with countries of the West, the East and the Far East, there will also be no difficulties in the future in exporting products of nonferrous metals.

Imports of products of nonferrous metallurgy have been relatively small, compared to the total imports of Yugoslavia. Imports of products of nonferrous metals amounted, on the average, to about 1% of the total imports. This can be seen from table on page 43.*

The biggest items in our imports of nonferrous metals are tin and ferro-alloys, which are not produced in Yugoslavia.

COPPER.

The production of copper and rolled copper goods in the last ten years can be seen from the following table** and diagram 3.

* Data: The Federal Bureau of Statistics and Records — Statistics of foreign trade.
** Data: Index № 11/1955 and № 2/1956

The products of „Elka", Zagreb

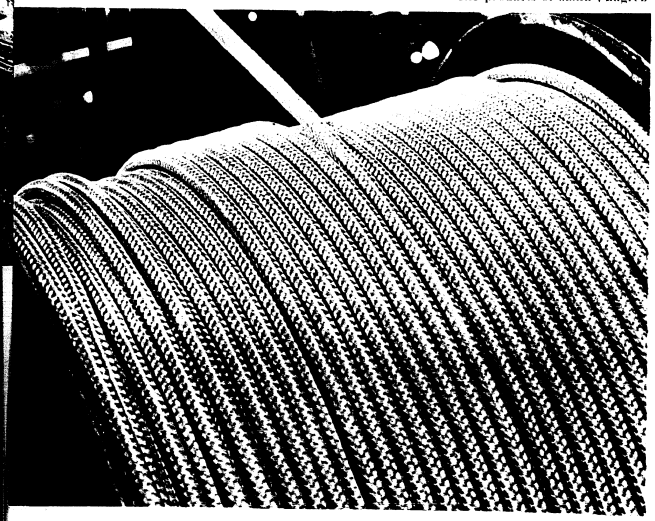
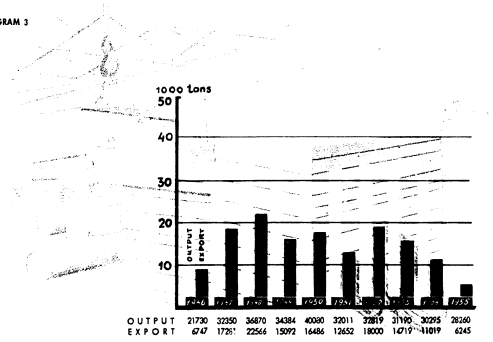


DIAGRAM 3



OUTPUT	21730	32350	36870	34384	40080	32011	37819	31190	30295	26260
EXPORT	6747	17251	22566	15092	16486	12652	18000	14719	11019	6245

In tons

Year	Copper ore	Blister copper	Electrolytic copper	Rolled copper goods	Cables	Other insulated conductors
1939	983,903	41,643	12,463	4,519*	65	572
1946	645,749	21,730	12,925	6,537*	1	1,467
1947	811,668	32,350	14,078	20,705**	84	1,824
1948	1,049,723	36,870	14,441	16,090**	186	2,514
1949	954,481	34,384	14,162	20,501**	733	3,134
1950	1,115,779	40,080	14,676	18,278**	752	2,634
1951	1,173,199	32,011	14,004	18,197**	734	2,324
1952	1,264,998	32,819	21,390	18,186	995	1,959
1953	1,343,563	31,190	27,764	16,783	1,238	2,406
1954	1,298,860	30,295	26,946	16,693	1,134	2,894
1955	1,476,863	28,260	24,837	21,708	1,672	3,609

* Data: from the Bureau of Planning.

Bor Mines

The whole output of copper comes from the well-known Bor Copper Mines, which celebrated their 50th anniversary in 1953. The magnitude of the copper deposit can be estimated by the total amount of copper produced. Till the end of 1954 the Bor Mines have yielded over 930.000 tons of copper. Over 300.000 tons of this total output were produced from 1945 till the end of 1954. The production of copper from Yugoslav mines amounts to 1.2 to 1.3 percent of the total world production of copper, and 32 percent of the total amount produced in Europe. Newly discovered ore reserves at Bor ensure, for another period of twenty years, a level of production amounting to 30,000 tons of copper annually. To maintain this output of copper, it

Tube and section rod drawing department in the Copper Rolling Mills, Sevojno

has been necessary to make considerable capital investments, in order to effect a rise in production and ore processing capacity. This is to be attributed to the constant fall in the percentage of copper in the ore. To maintain the same level of production, it is necessary to mine larger and larger quantities of ore. In 1939 there were mined 983,903 tons of ore with 5.20% of copper content from which 41,643 tons of blister copper were produced, while in 1953 a total of 1,343,563 tons of ore were mined, with only 2.66% of copper content from which only 31,190 tons of copper were produced.

Since the last war, the productive capacity of the mines and of the flotation plant has been constantly increased. The capacity of the flotation plant has been raised from 2,000 to 4,000 tons of ore per day. In 1956, a new expansion of the flotation plant will be completed, raising its capacity by another 3,000 tons, so that the total nominal capacity of the flotation plant will be 7,000 tons of ore per day. Together with this expansion of the flotation plant, work in the mine pits has gone forward. In the near future, a new shaft will be completed, which will make an increased output in the pits possible.

Among other important plants, a new copper electrolytic plant has been erected, its yearly output amounting to 28,000 tons of electrolytic copper. In this way, and taking into account the 14,000 ton yearly output of the old copper electrolytic plant about 42,000 tons of copper in all can be refined at Bor mines each year. With the erection of this electrolytic plant, the whole output of blister copper, since 1953, is refined in the country. A new cyanidation plant for gold started working in 1954, and it treats daily about 1,000 tons of quartz sand ore of the »iron hat« of copper deposits thus producing additional quantities of gold.

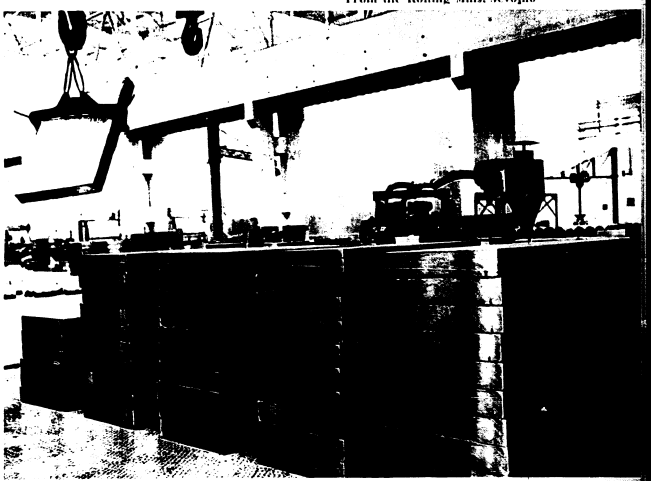
Besides these plants, a new machine and repair shop has been built together with a water-supply system as well as other installations. Till the end of 1954, about 900 family flats were also built, and dormitories with over 2,000 beds for single workers.

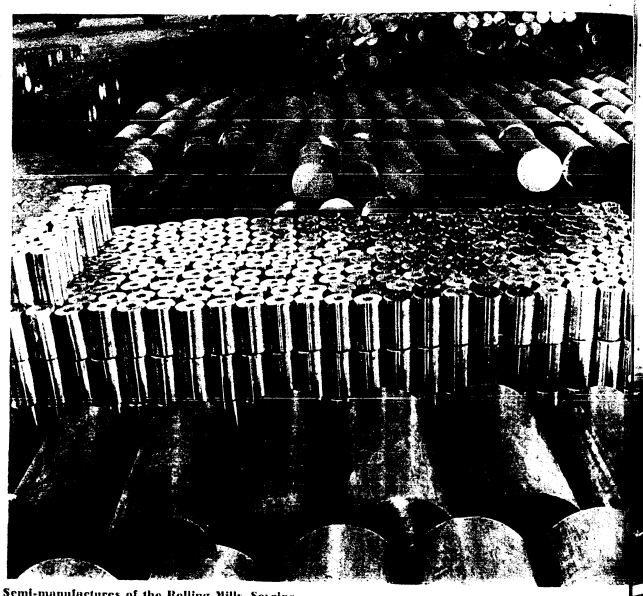
Copper produced by Bor Mines is of a very high grade, and is wellknown on the world copper markets. Blister copper content of pure copper was 99.3% while the copper content of electrolytic copper was 99.96% in 1954.

Copper manufacturing industry

In the post-war period, the copper ore processing industry has especially developed.

From the Rolling Mills, Sevojno





Semi-manufactures of the Rolling Mills, Sevojno

Coper rolled goods till the end of 1954, came from several plants which worked in a small way even before the last war, and which increased their productive capacity after the war. Among these factories are »Impol« in Slovenska Bistrica, which produced rolled products of copper and copper alloys; the »Novkabel« factory in Novi Sad, which produces cables, insulated copper wire, and rolled goods; »Elka«, in Zagreb, which produces chiefly cables and insulated copper wire; the »Maribor Foundry« which produces chiefly drawn products of copper and copper alloys. The total output of all these factories amounts to about 25,000 tons of rolled products of copper and copper alloys, and about 4,700 tons of cables and insulated copper wire.

In the last few years two new copper fabricating plants have been erected in Yugoslavia, viz.: the Copper and copper-alloy rolling-mills of Sevojno, and the Cable Factory of Svetozarevo.

The Copper and Copper-Alloy Rolling-Mills of Sevojno

This plant has been erected in the close vicinity of the town of Titovo Užice, and it produces copper sheets, copper bands, locomotive fireboxes, brass sheets, brass bands, brass rondelles, bi-metal bands (steel-tombac, or steel-copper, coated on one side), copper foil, copper tubing, copper rods, brass tubing, brass rods, special brass rods. The total productive capacity of the rolling-mills of Sevojno is 24,100 tons of finished rolled goods annually.

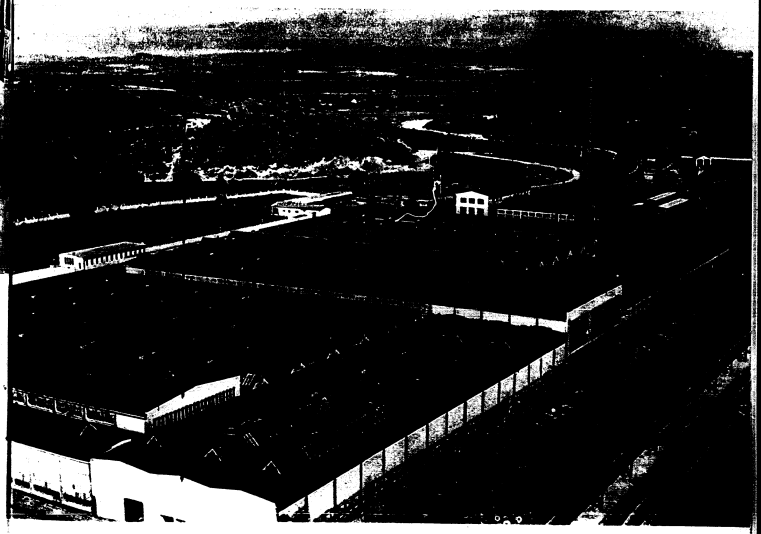
Its technological process and general features make it one of the most modern plants of the kind. The total floor surface of the plant is 43,500 square metres. The factory comprises:

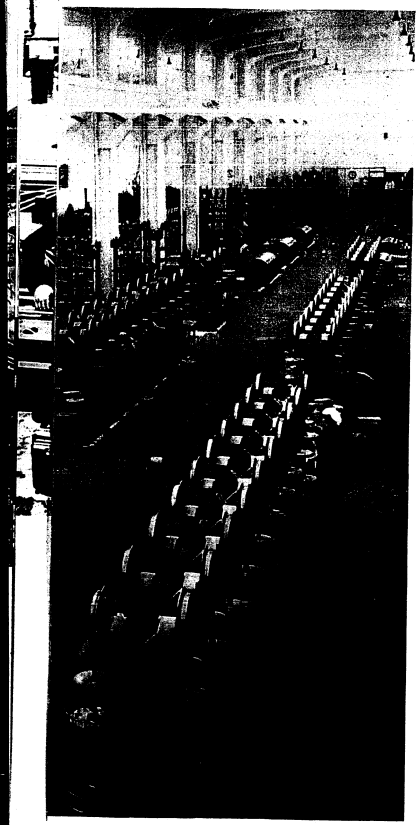
a) a foundry with storage facilities for stocks of metal, a foundry for ingots and castings equipped for mechanical handling of cast products and facilities for storage;

b) the rolling-mills, with a hot rolling mill with three rolling gangs, and a cold mill with four main rolling tracks;

c) a pressing-machine, which includes equipment for pressing tubing and structural shapes, and tools for drawing tubes and rods.

Cable Works, Svetozarevo





The greater part of the equipment for the rolling-mills of Sevojno has been imported from Western Germany.

The rolling-mills of Sevojno started working toward the close of 1954, while in 1955 most of its departments were in full swing.

The Cable Factory of Svetozarevo

This factory will produce lead sheath cables for power transmission lines up to 35 kV, paper-insulated; cables for power transmission lines up to 1 kV, rubber-insulated; insulated cables for electric power stations; cables and insulated telephone wires; rubber-insulated copper wire with a lead sheath for a voltage up to 500 V; cotton-insulated wire; copper wire and copper wire woven cables; steel wire cables, concrete reinforcing steel rods, from 6 to 8 mms thick, and lead tubing.

The productive capacity of this factory is 4.500 tons of rolled copper products, 25,000 tons of cables, over 2.000 tons of dynamo and varnished wire, over 2.000 tons of insulated copper wire, and about 35.000 tons of steel rods for reinforced concrete.

The technological process of the factory has been arranged in such a way, that the factory itself produces all the subsidiary materials for the production of cables and insulated conductors. All power drives function automatically with controls. The whole factory takes up 64.500 square metres of space. The chief factory building is within this area, and close to it is the office-building, with cloak-rooms and staff and management offices, the other buildings being those taken up by the foundry, the gas-generators, the steam-boiler, the repair shop, and the garage.

The technological process of the Cable factory of Svetozarevo includes, among other things:

From the Cable Works, Svetozarevo

a) the metallurgical department, comprising the foundry, the rolling-mill, wire and wire-rope production;

b) the electric power transmission cable department, which includes an insulating and wire twisting section, a section for impregnating and reinforcing cables, and a section for enamelling and varnishing wire;

From the Cable Works, Svetozarevo

c) the department of cables for telecommunication, comprising a section for twisting wire and telephone cables, a section for electroplating wire with tin, a section for the production of rubber-insulated wire, a section for the production of rubber-insulated wire with a lead sheath, and a section for impregnating tape with rubber, and for cutting bands.

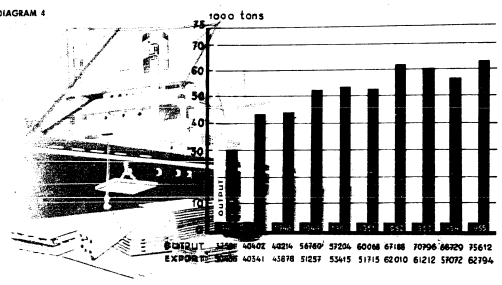
The greater part of the equipment of this factory has been bought abroad, out of a loan given to Yugoslavia by the International Bank.

The Cable factory of Svetozarevo started working partially in 1954, while several of its departments have been working only since last year.

With the erection of these new plants, and taking into account the old ones, Yugoslavia's productive capacity now amounts to about 38,000 tons* in the production of rolled goods, and to about 35,000 tons of cables, insulated conductors, cotton-insulated wire and varnished wire. Owing to this, the copper industry of Yugoslavia has taken on a fabricating character.

* Not taking into account the rolling-mill of »Impol«, which is turning to the rolling of aluminium.

DIAGRAM 4



Prospects of development in the future

Big results have been achieved especially in the increase of ore reserves. Besides an increase in the ore reserves of the Bor mines themselves, new copper ore reserves have been discovered at Majdanpek in East Serbia. Copper ore was discovered at Majdanpek in 1949, in the andesite massive of East Serbia, which stretches over 1.000 square kilometres of ground, at the eastern edge of which are the Bor Mines. The ore reserves here show a constant increase, from year to year, amounting to 160 million tons of copper ore at the beginning of 1955, with a little over 0.80% of copper per ton of ore.

These reserves, which contain today over 1 million tons of recoverable copper, their relatively highly economical exploitation, owing to the fact that the ore can be mined by open-cut mining, the ever-growing consumption of copper in the world, newly erected domestic plants for fabricating copper products which have a capacity greater than the present copper production in Yugoslavia, the possibility of a fuller recovery of copper ores, i. e. the recovery of sulphur present in copper ores (which up till now has been done), — all this constituted the fundamental economic and technical elements for the making of a new project known under the name of »The Majdanpek Project«.

This project plans:

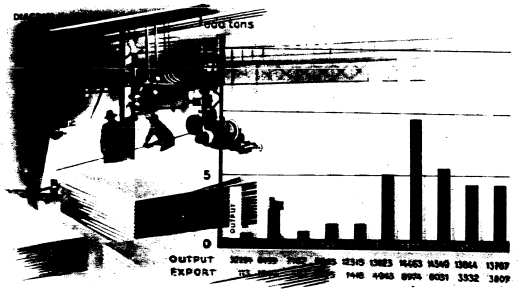
— the opening of the mine and the erection of a flotation plant at Majdanpek, where 3.600.000 tons of copper ore annually will be mined and treated by means of flotation processes;

— the erection of a new copper and sulphuric acid smelter at Bor, producing about 55.000 tons of copper (25.000 tons from Majdanpek copper concentrates, and 30.000 tons from Bor copper concentrates) and 230.000 tons of sulphuric acid;

— the erection of a superphosphate factory at Prahovo, which will use sulphuric acid from Bor to produce about 575.000 tons of superphosphates annually.

Besides copper and superphosphates, a considerable amount of gold and silver will be obtained.

By carrying out this project, Yugoslavia will be able to do much towards putting into effect her new economic policy, as the total amount of copper to be pro-



Lead blocks from the Trepča Mines

Lead Mines and Smelting Works, Mežica

duced will be exported in the shape of electrolytic copper and manufactured copper products, and in this way our clearing balance abroad will be very much improved. And besides, the production of superphosphates is of great importance to our agriculture.

LEAD AND ZINC

The production of lead and zinc in our country for the last ten years is shown in the following table and diagrams 4 and 5.

Yugoslavia was well-known even before the war for her rich lead and zinc ore deposits. During the 70 year period from 1875 till 1945 great quantities of ore were mined, which yielded ore from which were produced 1.066.399 tons of lead and 635.184 tons of zinc.* While in the post-war period, up till 1954 inclusively, over 10.3 million tons of ore were mined, from which 546,144 tons of lead and 217.657 tons of zinc (together with concentrates which were exported) were obtained. This is more than half the amount of lead and about 30% of the amount of zinc produced during the preceding 7 decades.

* Data relative to pre-war production taken from the book »The historical development of our mining«, by Dr. V. Simić.

In metric tons

Year	Lead and zinc ore	Refined lead	Crude zinc and zinc powder	Rolled goods	
				Lead	Zinc
1939	774,772	10,651	4,918		
1946	617,696	32,591	3,294		
1947	739,361	40,402	6,499		
1948	850,652	49,214	7,167		
1949	1,073,562	56,760	9,903		
1950	1,186,724	57,204	12,315		
1951	1,188,590	60,068	13,223		
1952	1,203,764	67,180	14,463		1,364
1953	1,432,100	70,796	14,549	2,191	1,328
1954	1,431,522	66,729	13,644	3,095	1,872
1955	1,650,178	75,612	13,767	3,709	2,078

Lead shot — the products of the Lead Smelting Works, Mežica

This output was made possible by the constant increase in the ore reserves and by the erection of new plants for the production and processing of lead and zinc ores.

The more important newly erected plants are:

Trepča. — A new shaft has been sunk at the mines, 800 metres deep. The capacity of the flotation plant, amounting to 2.500 tons of ore per day in 1939, has been raised to 3.000 tons. From 25.000 tons of copper production just after the war, the output of the smelter has been raised up to between 75.000 and 80.000 tons annually. A new Newman hearth was built in the smelter, as well as a big blast furnace, a small blast furnace, a Dwight-Lloyd system, and electric filters, while the productive capacity of the refinery has been raised. A silver and gold refinery was also erected.

Lead tubes

From the „Boris Kidrič" Combined Aluminium and Alumina Plant, Kidričevo

Mežice. — The productive capacity of the separation plant has been raised from 500 to 2.000 tons of ore per day, this resulting from an increase in the productive capacity of the flotation plant up to 1.000 tons, and a heavy liquid separation plant has been constructed, which is the first separation plant of its kind for nonferrous metallurgy in Yugoslavia. The lead smelter is now being reconstructed.

Zletovo. — An increase in the output of the mine has resulted from the opening up of new ore veins, and the system of transport has been improved. The capacity of the flotation has been raised from 500 to 1.000 tons of ore per day.

Kopaonik. — The mine and the 11 kilometres long aerial ropeway have been completely reconstructed, as the mine had been destroyed during the war. The ore from Kopaonik is processed at Trepča Mines (Zvečan).

Ajvalija-Janjevo. — The mines have been opened and they have started working. A shaft has been sunk, and an aerial ropeway constructed, as well as a standard gauge railway which serves to transport the ore mined to Trepča Mines, to be processed there.

Novo Brdo. — The mine has been opened, an aerial ropeway constructed and a flotation plant erected, with an output of 250 tons of ore per day.

Rudnik. — The mine has been opened, an aerial ropeway constructed, and a flotation plant erected, with an output of 500 tons of ore per day.

Lece. — The mine has been opened, an aerial ropeway constructed, and a cyanidation flotation plant erected, with an output of 250 tons of ore per day.

Veliki Majdan. — The mine has been opened, and a flotation plant erected, with an output of 100 tons of ore per day.

Šuplja Stena. — The mine has been opened, an aerial ropeway constructed, and a flotation plant erected, with an output of 250 tons of ore per day.

The Zinc Smelter of Celje. — The output, which amounted to 5.000 tons of zinc annually, before the war, has been raised up to 15.000 tons.

The Zinc Electrolysis of Šabac. — The erection of a new electrolytic zinc plant will be completed in 1956, and it will have an output of 12.000 tons of electrolytic zinc, 35 tons of cadmium, and 25.000 tons of sulphuric acid annually.

Owing to these new plants and to the extension of the old ones, the following advantages have been gained:

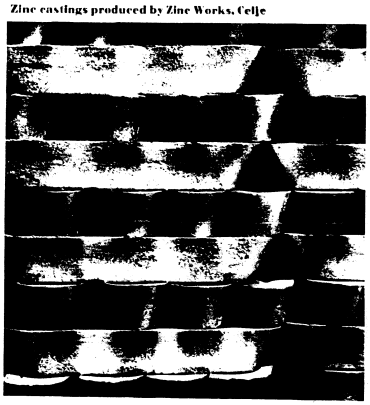
— the available ore reserves are being utilized;

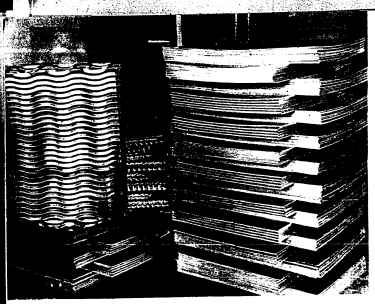
— an increase has been effected in the output of lead, zinc and other metals obtained as by-products in the process of processing lead and zinc ores;

— the whole amount of lead concentrates is refined in our country, and an ever greater part of the zinc concentrates is being refined here too;

— the export of lead and zinc products from our lead and zinc mines is constantly growing in quantity.

Zinc castings produced by Zinc Works, Celje





The products of Zinc Works, Celje

Lead and zinc ores are important also because during their processing other metals are obtained as their »by-products«. Thus, for instance, a considerable amount of silver is present in most of these ores. Thanks to this, Yugoslavia is the biggest producer of silver in Europe. The production of silver rose from 1.303 kilos, the amount produced in 1939, to a level of 90.000 kilos in recent years (94.804 kilos were produced in 1953, and 92.800 kilos in 1955*). Over 96% of this amount comes from lead and zinc mines. Bismuth too is obtained from lead and zinc mines, so that Yugoslavia produces this metal as well. In 1939 this metal was not produced at all, while in post-war years its production has been increasing constantly. In 1954 as much as 109.699 kilos were produced.** The lead and zinc ores from some of the mines (Lece, Novo Brdo) contain gold too, and the gold is separated in the refining process of these ores. Besides these metals, we get pyryte concentrates (Trepča). As soon as the zinc electrolytic plant starts working, cadmium too will be obtained. There is a considerable percentage of sulphur (in pyrrhotine form) and iron in these ores, and their recovery will be begun in the coming years. Present in these ores too is a considerable percentage of manganese, the possible recovery of which is being studied.

The country's needs for lead and zinc have so far been satisfied in full, and there is every prospect that they will be so in the future too. Lead and zinc have chiefly been exported up till now. Thus, of the 511.144 tons of lead produced in the period from 1945 to 1954 the greater part, amounting to 464.000 tons, was exported, and in the years just after the war*** another 44.673 tons of lead concentrates were exported. The mines which have been opened and the plants erected make possible further export of considerable quantities of lead and zinc.

The part which Yugoslavia plays in the world production of these metals is a very important one. Yugoslavia takes first place in European and seventh place in the world production of lead in lead and zinc mines, in recent years. In the production of zinc from ores she takes fifth place in Europe and twelfth place in the world. Yugoslavia's production of lead in lead and zinc mines amounts to about 4.5% of the total world output, and that of zinc to about 2.3% of the total amount produced in the world.

The refined lead produced by Trepča Mines is high grade material (99.9815% lead), as well as that produced by Mežice (99.992% lead).

Crude zinc produced by the Factory of Celje reaches the high grade of 97.90% zinc, and its refined zinc reaches the grade of 98.80% zinc.

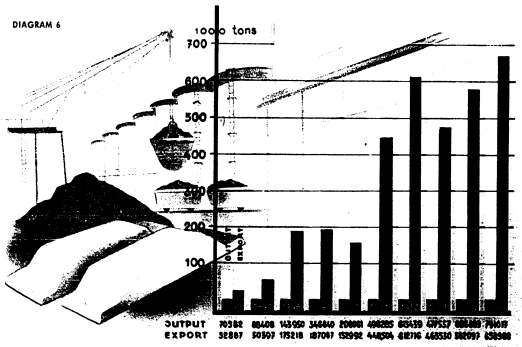
The grade of zinc to be produced by the electrolytic plant in Šabac is to be as high as 99.99% zinc.

Plants for the production of lead and zinc rolled goods

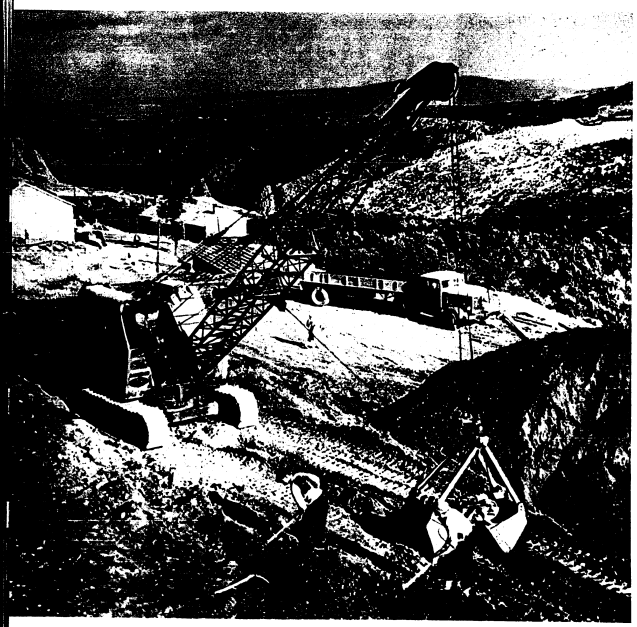
Beside smelting plants which produce lead and zinc, there are in Yugoslavia rolling-mills for these metals. The »Mežica Mines«, with their rolling-mills, can produce about 2.000 tons of lead sheets, about 1.000 tons of lead tubing, and approximately 1.000 tons of lead shot.

Plants of the Lead Products Factory in Zagreb can produce 1.500 tons of sheets and approximately 3.500 tons of lead tubing.

The newly erected Copper Rolling-Mills of Sevojno and the Cable Factory of



* Index № 2 1956
** Index № 11 1955
*** Not taking into consideration the year 1945



Bauxite mines at Crna Mlaka near Mostar

Svetozarevo can both produce rolled lead goods.

In the Zinc Factory of Celje which produces with its zinc smelters crude zinc, zinc dust and fine zinc powder, redistilled and refined zinc ingots, the productive capacity of the lead rolling-mill has been raised. This rolling-mill produces zinc sheets from 0.10 mm upwards, zincographic plates, plates for loose-leaf records, protectors, laundry, and so on. This rolling-mill has a productive capacity of about 4.000 tons of zinc sheets annually.

Development prospects

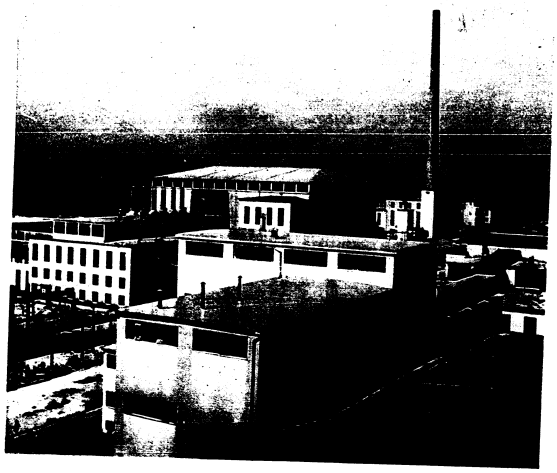
Ore reserves have so far been developed to such a degree that they can keep production at the achieved level of about 70,000 tons of lead and from 27,000 to 33,000 tons of zinc for many years to come. The erection of lead smelters and lead and zinc rolling-mills has made a greater output possible. Potential reserves of lead and zinc ores are far from being sufficiently exploited. At present there are 11 lead and zinc mines working, and 2 are in construction. These figures in themselves show how widespread the ore deposits of lead and zinc are in Yugoslavia. If the numerous outcrops and the old mines dating from the Middle Ages are taken into account too, as well as the prospecting undertaken recently, it becomes quite clear what the future prospects in this field of economic activity look like. It is planned to open, in the next few years, two new lead and zinc mines Kišnica, near Trepča, and Srebrenica, near Zvornik. Quite probably several other mines will be opened up in a few years, which are now being explored and studied.

ALUMINIUM

Diagram 6 and the following table* show how the production of bauxite and aluminium has been progressing.

* Index № 11/1955

The „Boris Kidrič" Combined Aluminium and Alumina Plant, Kidričevo



In metric tons

Year	Bauxite	Alumina	Aluminium	Aluminium rolled goods
1939	718,594	6,400	1,797	15
1946	70,562	1,857	567	124
1947	88,408	6,405	1,263	630
1948	143,950	5,586	1,884	1,125
1949	346,640	5,556	2,493	974
1950	206,061	6,450	1,931	1,750
1951	498,285	8,528	2,828	2,221
1952	613,439	8,960	2,563	1,730
1953	477,557	8,810	2,792	2,011
1954	686,689	13,979	3,492	2,893
1955	791,017	44,979	11,499	6,466

Yugoslavia is one of the richest countries in bauxite ore deposits. Bauxite deposits are to be found mostly all along the Adriatic coast. But bauxite is mined only in some of the regions rich in bauxite deposits, viz., in the following places, taking them in their order, from North to South, down the Adriatic coast: Rovinj, in Istria; Drniš, in Dalmatia; Mostar in Hercegovina; and Nikšić, in Montenegro. Of recent years, bauxite mining has been going on, on a smaller scale, in some other places (Umag, in Istria; Bosanska Krupa, in Bosnia). As our aluminium industry was rather poor till recent times, over 90% of the bauxite mined was exported. The Al_2O_3 content in the bauxite exported ranged from 52 to 60%, that of SiO_2 from 2 to 4%, which means that Yugoslav bauxite is of a very high grade. Owing to bigger domestic consumption in 1955, and a further rise in export, the production of bauxite in 1955 surpassed pre-war production.

Aluminium was produced, up to 1954, in small quantities by »Moste« near Ljubljana, and by Lozovac, near Šibenik.

It is held, not only by Yugoslav own experts, but by the experts of the United Nations, too, that Yugoslavia has, after Norway, the most favourable conditions for the production of aluminium in Europe. These favourable economic conditions comprise the following: the possibility of producing hydro-electric power at low cost, relatively big reserves of ore and raw materials, sufficient reserves of low-grade cgal, and relatively favourable transport conditions.

Besides these general economic conditions, other conditions of a more specific nature in Yugoslavia require the further development of aluminium industry. A very low home consumption (0.26 kg per inhabitant), and favourable opportunities for exporting this metal, the world consumption of which, it is believed, will rise from 2.4 million tons (the amount consumed in 1953) to 7 million tons by 1975, — all this speaks in favour of the further development of aluminium industry in Yugoslavia.

Yugoslavia has up till now taken great pains and invested considerable funds to build up the aluminium industry. Of the new big plants built recently one deserves especially to be mentioned, viz.:

The Alumina and Aluminium Plant, »Boris Kidrič« at Kidričevo, near Ptuj, with a productive capacity of approximately 50,000 tons of alumina and 15,000 tons of aluminium. It started work toward the end of 1954, and in 1955 it produced 33,000 tons of alumina and 8,243 tons of aluminium.

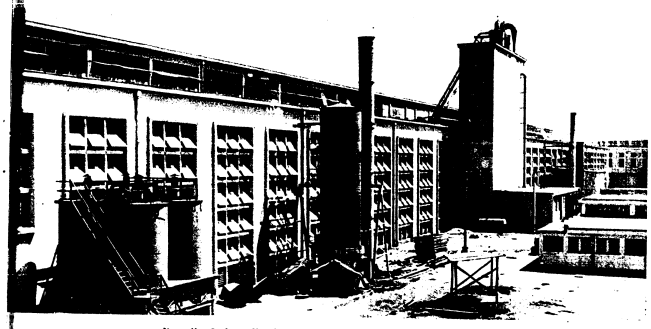
As the above table shows, the production of aluminium in Yugoslavia, until the »Boris Kidrič« plant was built, was a small affair. For this reason, and in spite of conditions very favourable to the production of aluminium, Yugoslavia had to import this light metal and to set limits for its consumption in the country.

The importance of the rise in the production of aluminium effected lies primarily in the fact that Yugoslavia is now among the countries which will, along with their economic development, increase in corresponding measure their consumption of aluminium.

At Kidričevo, beside the aluminium factory and the aluminium electrolytic plant, a foundry was built, and a thermal power station, and an electric and mechanical workshop, a laboratory, a plant for the production of phenol, sanitary buildings, a storehouse for bauxite and alumina, as well as other buildings. An anodes material factory will soon be finished too. At Kidričevo 35 apartment houses with flats have also been built, with a total of over 40.000 square metres of floor-surface.

The aluminium produced at Kidričevo so far, during the first year of production, is of a very high grade, ranging from 99.5% to 99.7% Alumina too is of high grade quality. Aluminium, as well as alumina has been exported from Kidričevo in 1955.

Conditions at Kidričevo are very favourable for raising the productive capacity of the aluminium electrolytic plant from 15.000 tons up to 30.000 tons. The electric power station and installations have been made to correspond to a production of 30,000 tons. The foundations of a new electrolysis plant have also been laid. Relatively small means are needed to double the aluminium production capacity at Kidričevo.



Detail of the „Boris Kidrič" Combined Aluminium and Alumina Plant, Kidričevo

Aluminium fabricating industry

The production of aluminium and aluminium-alloys rolled goods was rather insignificant till 1954, and was all limited down to two factories, namely copper alloys and aluminium rolling-mills »Impol« near Slovenska Bistrica, and the enterprise »Metal«, at Otočac, near Zagreb. The »Impol« rolling-mills produced bare aluminium cables, rolled and drawn products of aluminium. Two big new rolling-mills will soon be finished for producing aluminium and aluminium alloys goods, viz. The »Impol« rolling-mills near Slovenska Bistrica, and the factory of light metals »Boris Kidrič« near Šibenik.

The „Impol" Rolling-Mills

The present copper, copper-alloys and aluminium and aluminium alloys rolling-mills of »Impol« are going to turn completely to the production of rolled goods of aluminium and its alloys. The job of pro-

ducing copper rolled goods, which this plant has partly been doing up till now, is going to be taken up altogether by the newly erected plants, the copper rolling-mills of Sevojno and the Cable factory of Svetozarevo.

This rolling-mill for nonferrous metals, after it has been reconstructed, will have a productive capacity in the years soon to come of approximately 10.000 tons of rolled aluminium goods.

The new buildings of the plant have a floor-surface of nearly 25.000 square metres. The plant already produces rolled sheets of aluminium and aluminium alloys, rolled bands of aluminium and of its alloys, and other rolled goods as well, drawn aluminium wire and drawn wire of aluminium alloys, drawn bars of aluminium and its alloys, drawn tubing of aluminium and aluminium alloys, and all the other drawn products of aluminium (aluminium welding-rods). Besides this, the plant produces bare aluminium cables and bare cables of aluminium-ferrum, with an output that is rapidly going up.

With the expansion which is now in full swing, this rolling-mill will have a greater variety of production. The building of the new machine-shop will be completed in 1956, and the machines will also be in place by then.

The Impol rolling-mill is quite close (about 20 km) to the aluminium plant at Kidričevo.

This oldest Yugoslav rolling-mill for nonferrous metals has experienced and highly skilled workers.

The light metals plant „Boris Kidrič" in Šibenik

The construction of the biggest rolling-mills for aluminium and aluminium alloys in Yugoslavia is being completed inside the plant of light metals „Boris Kidrič" near Šibenik. Beside the rolling-mills the factory has an aluminium electrolytic plant with a yearly output of 4.500 tons of aluminium ingots.

The capacity of the rolling-mill is about 16.000 tons of rolled goods annually.

The rolling-mill started working on trial in 1955 and it is going to produce smooth, ribbed, corrugated and coated sheets of all grades of hardness, and bands of various thickness, white and dark yellow foil (loose leaves or rolls), rondelles of varied thickness, bars, tubing, sections drawn up to 7.000 mm long and pressed up to 10.000 mm in length, etc.

The rolling-mill has the most modern equipment, imported from abroad, so it will be able to produce under economic production conditions, high-grade goods.

After the erection of these objects is completed, Yugoslavia will be able to produce approximately 1 million tons of bauxite annually, about 60.000 tons of alumina, about 22.500 tons of aluminium*, and about 26.500 tons of rolled aluminium goods. With the construction of the second phase of the aluminium electrolytic plant, the aluminium production capacity would be 37.500 tons annually.

The aluminium industry which has been built up in this period of ten years is important to Yugoslavia from several points of view. From the importer of aluminium and rolled aluminium goods that she had been, Yugoslavia has become an exporter of the same products. For this production domestic raw materials are used in the main namely, electric power, coal, and bauxite. The rise in output makes possible a much bigger domestic consumption of aluminium and of rolled aluminium goods, which, in its turn, contributes to the improvement of the general standard of living.

There is every chance for the production of aluminium to grow, in years to come by building new plants.

* Lozovac 3.000, the light metals factory near Šibenik 4,500 and Kidričevo 15.000 tons.

One of the workshop of the „Boris Kidrič" Aluminium and Alumina Plant, Kidričevo

MERCURY

The table below shows the production of mercury* in the last ten years (See diagram 7).

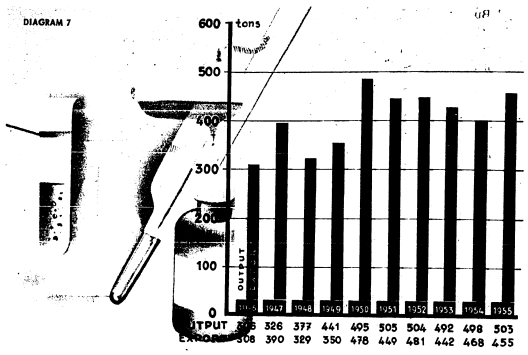
Year	Metric tons	Year	Metric tons
1939	378	1951	505
1946	306	1952	504
1947	326	1953	492
1948	377	1954	498
1949	441	1955	503
1950	495		

The production of mercury has an important place in the production and export of nonferrous metals in Yugoslavia. Yugoslavia has been recently producing 10% of the total world production of mercury. She is the third biggest producer of mercury in Europe, second only to Italy and Spain.

The whole amount of mercury produced comes from the Idria Mines. This old mine, where mining has been carried on since 1500, has long been wellknown in the world. Other mines of mercury, in other countries, took their name from this mine (New Idria, in U. S. A.). Since production began on a large scale and till 1955 this mine has produced 92.663 tons of mercury. Of this amount, 4,588 tons were produced in the post-war period, till the end of 1955. The greatest part of this very old metal, which is finding new uses today, has been exported during that period. Thus of the 4.588 tons produced, 3,235 tons were exported (not counting the year 1945).

The production level of about 500 tons has been maintained by processing greater and greater quantities of ore, because there is a steady fall in the metal content of the ore. While 154 tons of ore were needed in 1940 to get a ton of mercury, in 1954 as much as 279 tons of ore were needed. Because of this, the productive capacity of the mine and the smelter has been raised, and they have been modernized. Work is being done just now to fur-

* Index № 2/1956



ther modernize the mine and the smelter, and this will make it possible for the production of mercury to go up.

ANTIMONY

The production of antimony* of late years can be seen from the table below and from diagram 8.

In metric tons

Year	Antimony ore	Antimony Regulus
1939	18.963	1.500
1946	30.495	1.206
1947	35.804	1.390
1948	34.661	1.500
1949	49.077	1.643
1950	80.534	1.815
1951	55.088	1.229
1952	74.594	1.329
1953	61.450	1.410
1954	75.238	1.532
1955	80.474	1.607

* Index № 2/1956

Yugoslavia is the biggest producer of antimony from antimony mines in Europe. Up till 1950, the whole output came from the mining region of Zajača Mines and from the Bujanovac and Lisa mines. Toward the end of 1950 mining was stopped at Bujanovac because the ore had become too poor in antimony content. In the post-war period very considerable results have been achieved in the field of prospecting for antimony. This success is all the more important because after the liberation of the country the antimony mines were found practically without any ore reserves.

In the last ten years, up till 1954 inclusively 14.497 tons of antimony were produced, compared to 15.500 tons produced before and during the war. This output came chiefly from newly discovered, relatively poor ore deposits. This made it necessary to erect flotation and separation plants, in order to get rich concentrates. Four new separation-flotation plants were erected (Stolice, Dobri Potok, Brasina and Bujanovac). The total capacity of the flotation plants was raised from 200 to 550 tons per day. At present the whole output of antimony metal comes from the antimony smelter of Zajača.

Much the greatest part of the antimony produced is exported. Out of 13,074 tons of antimony, produced from 1946 to 1954, fully 11.876 tons were exported.

The antimony produced in 1954 reached the high grade of 99.57% Sb.

CHROME

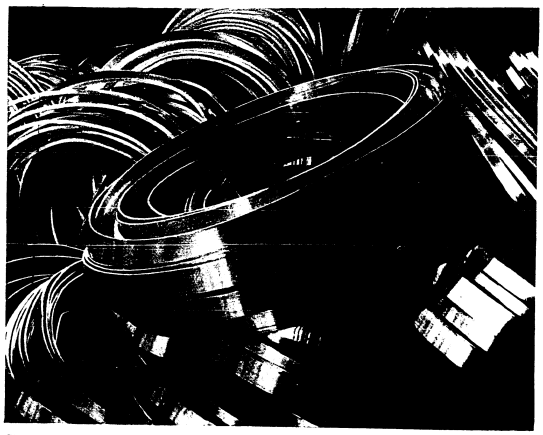
The production of chrome ores and chrome concentrates amounted as follows:

In metric tons

Year	Chrome ore of I II III class	Chrome ore of I & II class	Chrome concentrate
1939	44,852	43,934	14,695
1946	77,154	—	9,594
1947	75,754	33,817	17,465
1948	62,613	16,118	16,307
1949	109,120	27,632	15,060
1950	114,736	31,141	21,341
1951	99,639	32,659	24,653
1952	107,222	35,888	25,872
1953	126,961	33,035	23,777
1954	124,480	26,030	23,486
1955	126,297	21,017	29,979

Both crude chrome and chrome concentrates are produced in Yugoslavia. Cru-

The electrolysis workshop of the „Boris Kidrič" Aluminium and Alumina Plant, Kidričevo

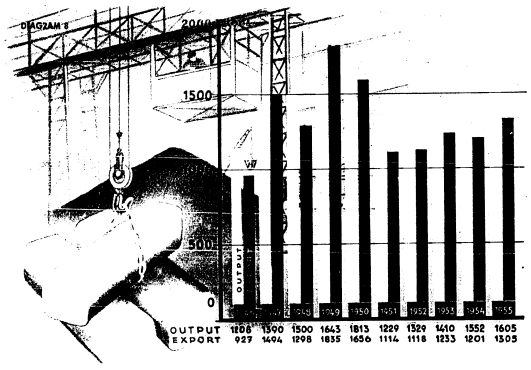


The products of the IMPOL Works, Slovenska Bistrica

de chrome of the 1st class produced has over 48% of chromite, of the II class from 42 to 48% of chromite, while chrome concentrate has over 48% of chromite.

The chrome produced comes chiefly from Raduša, Lojana and Đakovica (Deva). To maintain the production level needed to satisfy bigger domestic consumption and export of crude chrome and chrome concentrate, a new mine has been opened near Đakovica, and a new separation plant erected, this, too, near Đakovica. To make better use of poor ores, the capacity of the chrome separation plant near Gorce Petrov (a suburb of Skoplje) has been doubled. In this way, the capacity of all the separation plants together has been raised from 12.000 tons, the output immediately after the war, to about 35.000 to 40.000 tons of chrome concentrate annually. This production level was attained at great pains after the war. The magnitude of the task can be judged best by the fact that the Germans had excavated 437.000 tons of chrome ore during the war mostly the higher grade ore, without exploring for new deposits, so that the chrome mines were left with very small reserves of chrome ore.

Domestic consumption of chrome ore and concentrates has been going up considerably, owing to new plants having been erected, which use this ore more and more. Chrome ore and chrome concentrates are now used in Yugoslavia chiefly in the production of ferro-chrome at Ruša, and by the newly built factory of magnesium and chrome-magnesium bricks »Magnohrom«. From this year on, and as soon as the newly built factory of chrome compounds at Jugonovci starts working, domestic consumption will be still bigger. But, in spite



of this increasing consumption a certain amount both of chrome ore and concentrates, will be exported in the succeeding years.

FERRO-ALLOYS

The post-war production of ferro-alloys, up till 1955, has retained the same level it had before the war, because new plants for the production of ferro-alloys have not been completed yet.

Before the war, in 1939, the following ferro-alloys were produced in Yugoslavia:

Ferro-silicon	3.204 tons
Ferro-chrome	1.873 tons
Ferro-manganese	6.316 tons
Silico-manganese	806 tons

— giving a total of 12.199 tons.

There were no important changes in the production of ferro-alloys, either in quantity or in the variety of assortments.

Ferro-silicon was produced at Jajce, ferro-chrome at Ruše, and ferro-manganese and silico-manganese in Šibenik. Jajce and Ruše used domestic raw materials, while Šibenik, in addition to domestic manganese ores, used higher grade manganese ores which were imported.

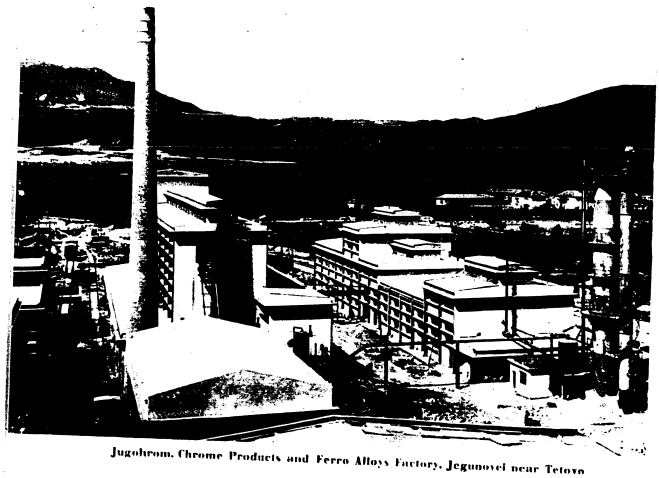
The production of ferro-alloys in this post-war period ranged from 10.000 to 16.648 tons (in 1955). Of late years, the production of precious ferro-alloys (ferro-tungsten and ferro-molybdenum) has been begun too.

To meet growing domestic needs and in order to export, the following plants are being erected now:

— Electrodes and Ferro-Alloys Factory in Šibenik, with a productive capacity of about 25.000 tons of ferro-alloys;

— The »Jugohrom« factory near Jegunovci, with a productive capacity of 7.000 tons of ferro-silicon.

Both of these factories will charge their blast furnaces, to produce ferro-alloys, in 1956 for the first time.



Jugohrom, Chrome Products and Ferro Alloys Factory, Jegunovci near Tetovo

After these factories are completed, the total productive capacity will be:

ferro-silicon	13.00 tons
ferro-chrome	3.500 tons
ferro-manganese and silico-manganese	23.500 tons
silico-calcium	1.300 tons
other ferro-alloys	400 tons

The best part of the output from these new plants is to be exported. A great part of the present output has been exported. Of the 11.551 tons, produced in 1954, about 4.494 tons were exported, while in 1953, out of the 10.605 tons produced, 4.420 tons were exported (In 1954 the 4.494 tons exported included 1.835 tons of ferro-chrome, 2.251 tons of ferro-manganese and 358 tons of other ferro-alloys).

OTHER PRODUCTS OF NONFERROUS METALLURGY

Besides the products which have been discussed above, enterprises of nonferrous metallurgy produce other metals too, such as the following: silver, gold, bismuth, selenium, pyrite concentrates, tungsten concentrate and so on. The production of many of these shows and increase, as can be seen from the table below.

In metric tons

Year	Gold* (in kilos)	Silver**	Bismuth**	Pyrite concentrates **
1939	2.224	1.5	—	78.064
1946	—	8.7	17.1	94.141
1947	679	36.0	42.7	175.859
1948	819	46.8	51.0	209.288
1949	1.076	59.6	38.1	172.033
1950	1.330	74.2	56.3	86.232
1951	1.304	94.3	87.8	113.541
1952	1.385	99.2	98.7	167.397
1953	1.139	94.8	98.5	165.833
1954	..	88.0	109.7	168.109
1955	—	92.8	104.1	226.682

Bismuth, silver, gold, selenium, pyrite concentrate, — all these are obtained in the process of refining lead and zinc and copper ores. The best part of these products is exported too.

* Statistics Annual of the Federative People's Republic of Yugoslavia for 1955.
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